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MYCOTAXON

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A contribution to the rust flora (Uredinales) of southern Africa, with an emphasis on South Africa*

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Abstract—Six new rust species are described: *Puccinia rocherpaniana* on *Helichrysum tricostatum*, *P. pteroniae* on *Pteronia divaricata*, *Uredo tarchonanthi* on *Tarchonathus littoralis*, *Uredo aspalathi* on *Aspalathus laricifolia*, *Uromyces silksvleyensis* on cf. *Bartholina burmanniana*, and *Uromyces quaggafonteinus* on *Ehrharta calycina*. Rust species newly recorded from the western provinces of South Africa and/or on new host plants are: *Aecidium elytropappi* on *Elytropappus rhinocerotis* and *Leysera gnaphalodes*, *Aecidium dielsii* on *Lebeckia* sp., *Miyagia pseudosphaeria* on *Sonchus* cf. *oleraceus*, cf. *Phakopsora pachyrhizae* on *Psoralea pinnata*, *Puccinia polycampta* on *Chlorophytum crassinerve* and on *Trachyandra* sp., *P. kalchbrenneri* var. *kalchbrenneri* on *Helichrysum cochleariforme*, *P. ursiniae* on *Ursinia anthemoides*, *P. granularis* on *Pelargonium grossularioides*, *P. menthae* on *Mentha* cf. *longifolia*, *P. hordei* on *Bromus pectinatus*, *P. polypogonis* on *Polypogon monspeliensis*, *P. stonemaniae* on *Thesium* cf. *strictum* and on *T. viridifolium*, *Uredo* sp. on *Salsola* cf. *zeyheri*, *Uromyces chaetobromi* on *Chaetobromus dregeanus*, *Uromyces ehrhartae-giganteae* (= *Uredo ehrhartae-calycinae*) on *Ehrharta calycina* and on *E. villosa*, *Uromyces holci* on cf. *Holcus setiger*, on *Karroochloa* cf. *schismoides*, on *Schismus barbatus* and on *Tribolium echinatum*.

Keywords—Biodiversity, Namibia, rust fungi, taxonomy.

Introduction

Up to 400 rust species (Crous, Phillips & Baxter 2000; Doidge 1950) and about 20.000 species of higher plants (Acocks 1953) are known from South Africa. If it is true that rust species are about 5-25% as numerous as plant species (Hennen & McCain 1993), a total rust flora of about 1.000 to 5.000 species could be calculated. Thus, it is likely that a lot more rust species are yet to be found in South Africa.

In the pilot phase of the BIOTA (Biodiversity Monitoring Transect Analyses) Southern Africa project extensive collections of rust fungi were made in the western parts of South Africa and in Namibia. For our first results, we describe six new rust species and we report the first recording of several rust species for South Africa and for Namibia. Furthermore, known rust fungi are shown to have extended host ranges, than currently accepted.

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* Part 216 in the series „Studies in Heterobasidiomycetes“ from the Botanical Institute, University of Tübingen.

Materials and methods

The examined specimens were mostly collected in the South African BIOTA-observatories by the first author and Markus Göker between 17.XI.2001–03.XII.2001 and by the first author between 02.IX.2002–30.IX.2002. The 13 BIOTA-observatories in South Africa were set up along a transect, parallel to the N7, from Cape of Good Hope to Richtersveld. Each observatory has one km^2. The specimens collected in the course of this study as well as some additional specimens from herbaria were studied as we performed freehand sections and scrape mounts of infected plant material. The samples were heated in "Hoyer's fluid" (Cunningham 1972) and subsequently examined with a Carl Zeiss microscope with bright field and phase contrast.

With the exception of pycnio- and basidiospores, 25 spores of each occurring spore state were measured. If only one collection of a rust species was available 50 spores of each present spore state were measured. The same was done with type collections. If a spore state is put in parentheses, measurements were not available. The reasons for that are either too small a number of spores or strong alterations of spores that had already germinated.

The cells of the peridium were also examined. In our line drawings, which show the cells as optical sections, the outer wall of the cells is on the left hand side, the inner wall on the right hand side. All specifications with the prefix 'circa' are based on measurements of less than 25 cells.

For the determination of the rust fungi the encyclopaedic publications of Doidge (1927, 1928, 1939, 1941, 1948a, 1948b, 1950) and Cummins (1971) were mostly consulted. In addition, we checked a lot of further publications concerning the rust flora of Africa which are available via internet under http://www.mycology.uni-tuebingen.de/databases/rust-literature/.

Results

The rust species are listed in alphabetical order referring to the host family and to the host genus, respectively. The following abbreviations are used: 0 = spermogonia = pycnia; I = aecia; II = uredinia; III = telia; IV = basidia.

ANTHERICACEAE – *CHLOROPHYTUM* & ASPHODELACEAE –*TRACHYANDRA*

Puccinia polycampta Syd. (Sydow 1924: 236). (Fig. 1)

Type on *Chlorophytum* sp. (as *Anthericum* sp.) South Africa, Western Cape Province, Stellenbosch, IX.1923, leg. L. Verwoerd No. 1260, (Langbaan No. 1270).

Pycnia unknown. Aecia not seen.

Uredinia amphigenous on leaves, sparse in the middle of concentric groups of telia, supepidermal, roundish or ellipsoid in outline, up to 2 mm diameter, dark brown to black, long covered by the epidermis which ruptures lately but always partly veiled, pulverulent, surrounded by mahogany-red leaf spots. Urediniospores subgloboid, ovoid or ellipsoid, 23–38 x 19–30 µm, finely echinulate, spores borne singly on pedicels, spore wall uniformly about 1.5–2 µm thick, yellowish to hyaline, germ pores inconspicuous, 8 to 13, scattered, with hyaline papillae that are weakly developed.

Telia amphigenous on leaves, separate or scattered in longitudinal deformed concentric groups, up to 1 cm diameter, partly surrounding one uredinium, subepidermal, dark reddish-black, long covered by the epidermis which ruptures lately but always partly veiled, single sori compact, surrounded by mahogany-red leaf spots, loculated by a well developed stroma of dark mahogany-brown, palisade-wise paraphyses. Teliospores in general bicellular, variable in shape and size, ellipsoid, clavate, oblong or irregular in outline, rounded, acuminate or flattened at the apex, rounded or attenuate at the base, slightly constricted at the septum, 38–65 x 18–30 µm, spore wall smooth, occasionally with longitudinal surface ridges, about 1–2 µm thick at the sides, about 2–8 µm thick at the apex, brown to (pale) chestnut-brown, germ pores obscure, pedicel persistent, up to 20 µm long, often truncate short below of the attachment, thin-walled, collapsing, reddish-brown to hyaline. Mesospores and tricellular spores present.

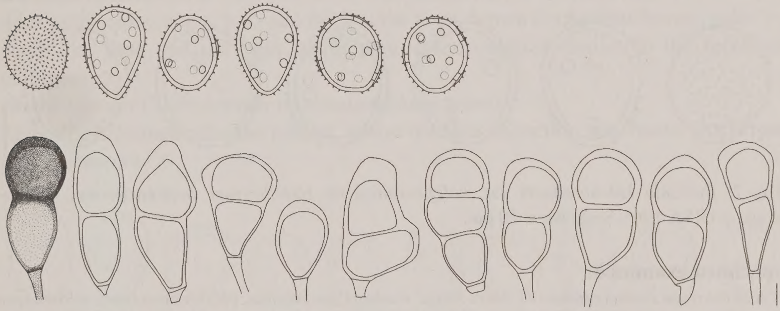

Fig. 1: *Puccinia polycampta* on *Chlorophytum crassinerve*. Uredinio- and teliospores (RSA 146). Scale bar = 10 µm.

Specimens examined:

- On *Chlorophytum crassinerve* (Bak.) Oberm. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 31.2'', E 17° 32' 45.1'', 11.IX.2002, leg. M. Mennicken No. RSA 146, II III (PREM, M).
- On *Trachyandra* sp. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 32.2'', E 18° 18' 23.3'', 19.IX.2002, leg. M. Mennicken No. RSA 187, II III (PREM, M).
- On *Trachyandra* sp. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 32.9'', E 18° 18' 24.0'', 19.IX.2002, leg. M. Mennicken No. RSA 195, II III (PREM, M).

Specimen not examined because of the scantiness of the infection:

- On *Trachyandra* sp. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 32.0'', E 18° 18' 40.1'', 21.IX.2001, leg. M. Mennicken No. RSA 18, III (PREM).

Our collections agree well with the diagnosis of *Puccinia polycampta* even if the spectrum of spore measurements is wider in our collections. Sydow (1924) stated for the urediniospores 24–27 x 20–25 µm and for the teliospores 36–44 x 18–24 µm. *Chlorophytum crassinerve* is a new host plant and *Puccinia polycampta* seems to be new to the rust flora of the Northern Cape Province.

ASTERACEAE - *HELICHRYSUM*

Puccinia kalchbrenneri De-Toni 1888: 645 **var. *kalchbrenneri*.** (Fig. 2)

Lectotype on *Helichrysum nudifolium* Less. South Africa, near Somerset East, Promont, leg. P. MacOwan.

Syn. *Puccinia helichrysi* Kalchbrenner & Cooke 1880: 21. Type on *Helichrysum petiolatum* D. Don, South Africa, No. 35.
Anamorph. *Uredo lepisclinis* Thümen 1877: 410. Type on *Helichrysum nudifolium*. South Africa, near Somerset-East, Promont, 1876, leg. P. MacOwan No. 1239.

Pycnia, aecia, and telia not seen.

Uredinia mostly abaxial on leaves, and on stems, sparse, separate or scattered in irregular groups, roundish to ellipsoid, small, up to 0.5 mm wide, yellowish-brown, exposed, pulverulent. Urediniospores globoid, subgloboid, or ovoid, 22–28 (–31) x 20–25 (–27) µm, finely echinulate, spores borne singly on pedicels, spore wall uniformly about 1–2 µm thick, bright yellow to hyaline, germ pores inconspicuous, 5 to 9, scattered, without papillae.

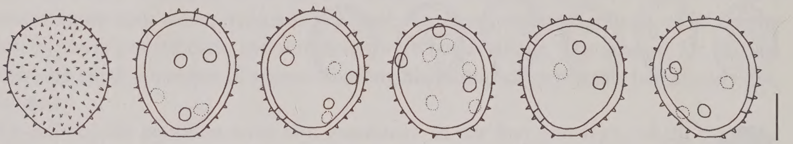

Fig. 2: *Puccinia kalchbrenneri* var. *kalchbrenneri* on *Helichrysum cochleariforme*. Urediniospores (RSA 196). Scale bar = 10 µm.

Specimen examined:

- On *Helichrysum cochleariforme* DC. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 25.6'', E 18° 18' 32.8'', 19.IX.2002, leg. M. Mennicken No. RSA 196, II (PREM, M).

Our collection conforms well with the description of the uredinia and urediniospores of *Puccinia kalchbrenneri* given by Gjærum (1998): "Uredinia hypophyllous, yellowish brown. Urediniospores (21–) 25–33 x 17–25 (–29) µm, globoid, subgloboid or obovoid, sometimes irregular, wall 1 µm thick, finely echinulate". *Helichrysum cochleariforme* seems to be a new host plant.

Puccinia rocherpaniana Mennicken & Oberw. sp. nov. (Fig. 3)

Pycnia et aecia ignota. Uredinia adaxialia, subepidermalia, vulpina, usque ad 1 mm diam., mox nuda, pulverulenta. Urediniosporae subgloboideae, ovoideae vel ellipsoideae, interdum angulatae, 25–35 (–38) x 21–30 µm, pariete echinulato, aureo-fusco vel olivaceo, 2–3 µm crasso, 3–6 poris germinationis dispersis. Telia adaxialia, subepidermalia, nigra, usque ad 1 mm diam., mox nuda, compacta vel pulvinata. Teliosporae bicellulares, obovoideae, ellipsoideae, clavatae vel oblongae, apice rotundato, acuto vel applanato, base rotundata vel attenuata, medio leviter constrictae, 36–69 µm x 21–37 µm, pariete laevigato, brunneo vel castaneo, lateraliter 1–2.5 µm crasso, apicaliter 4–14 µm crasso, poro germinationis cellulae superioris apicali, cellulae inferioris juxta septum posito, pedicello dilute aureo-fusco vel hyalino, usque ad 65 µm longo. Mesosporae numerosae, ellipsoideae vel oblongae, apice acuto vel rotundato, base attenuata vel rotundata, 30–46 x 17–26 µm, pariete laevi, brunneo vel castaneo, lateraliter 1–2 µm crasso, apicaliter 3–11 µm crasso, poro germinationis apicali.
In foliis *Helichrysi tricostati* (Thunb.) Less. (Asteraceae).

Pycnia and aecia unknown.

Uredinia adaxial on leaves, subepidermal, sparse, separate or scattered, roundish in outline, small, up to 1 mm wide, foxy red, exposed, pulverulent, surrounded by the torn epidermis. Urediniospores subgloboid, ovoid or ellipsoid, sometimes irregularly angular, 25–35 (–38) x 21–30 µm, finely echinulate, spores borne singly on pedicels, spore wall uniformly about 2–3 µm thick, brownish-yellow to olive-green, germ pores inconspicuous 3 to 6, scattered, with hyaline papillae that are weakly developed.

Telia adaxial on leaves, subepidermal, developing from the uredinia, sparse, separate or scattered, black, exposed, compact to cushion-like, surrounded by the torn epidermis. Teliospores in general bicellular, variable in shape and size, obovoid, ellipsoid, clavate or oblong, rounded, acuminate or flattened at the apex, rounded or attenuate at the base, slightly constricted at the septum, 36–69 µm x 21–37 µm, spore wall smooth, about 1–2.5 µm thick at the sides, about 4–14 µm thick at the apex, brown to chestnut-brown, paler towards the base and the apex, germ pores apical and just below the septum, pedicel persistent, up to 65 µm long, thin-walled, mostly collapsing, brownish- yellow to hyaline. Mesospores common, ellipsoid to oblong, acuminate or roundish at the apex, attenuate or roundish at the base, 30–46 x 17–26 µm, spore wall smooth, about 1–2 µm thick at the sides, about 3–11 µm thick at the apex, brown to chestnut-brown, paler towards the base and the apex, germ pore apical, pedicel similar to the bicellular teliospores.

On the leaves of *Helichrysum tricostatum* (Asteraceae).

Etymology. Named after the habitat, where the first collection was made, Rocherpan Nature Reserve.

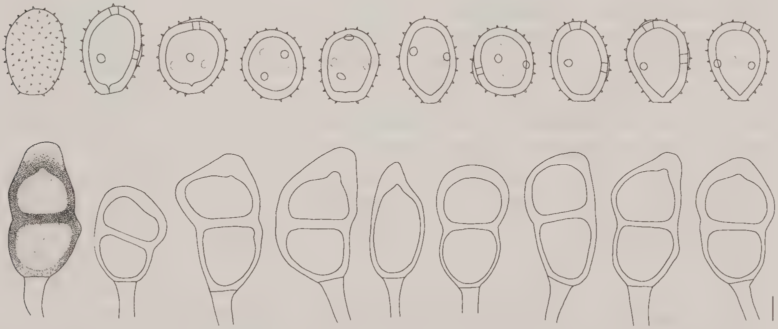

Fig. 3: *Puccinia rocherpaniana* on *Helichrysum tricostatum*. Uredinio- and teliospores (RSA 136). Scale bar = 10 µm.

Specimens examined:

- On *Helichrysum tricostatum*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 27.0'', E 17° 32' 40.1'', 11.IX.2002, leg. M. Mennicken No. RSA 136, II III (Holotype PREM, Isotype M).
- On *Helichrysum tricostatum*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 26.9'', E 17° 32' 40.1'', 26.XI.2001, leg. M. Mennicken No. RSA 52, II III (Paratypes PREM, M).
- On *Helichrysum tricostatum*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 33.3'', E 18° 18' 36.3'', 21.XI.2001, leg. M. Mennicken No. RSA 21, II III (Paratypes PREM, M).
- On *Helichrysum tricostatum*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 24.4'', E 18° 18' 47.9'', 21.XI.2001, leg. M. Mennicken No. RSA 22, II III (Paratypes PREM, M).

- On *Helichrysum tricostatum*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 32.3'', E 18° 18' 24.7'', 19.IX.2002, leg. M. Mennicken No. RSA 198, II III (Paratypes PREM, M).

As far as could be established, there are five known *Puccinia* and one *Uredo* species on the host genus *Helichrysum*:

The autoecious, macrocyclic *Puccinia kalchbrenneri* (see above) differs from *Puccinia rocherpaniana* in having smaller, thinner-walled urediniospores: "20–30 x 19–26 µm" (Pole Evans 1915), "(21–) 25–33 x 17–25 (–29) µm, … wall 1 µm thick" (Gjærum 1998), and narrower, thinner-walled teliospores having a thinner apex and short, often fragile pedicels: "40–73 x 15–23 µ, rarely up to 27 µ broad, the majority being 40–57 x 15–22 µ, epispore smooth, delicate, thin, pale except of the apex where it is thickened (up to 10 µ) and chestnut brown; … pedicel short, deciduous" (Doidge 1927), "42–66 x 21–27 µm, … walls pale brown, 1 µm thick, apically darker brown, up to 7 µm thick. Pedicels up to 30 µm long, often deciduous" (Gjærum 1998).

Puccinia kalchbrenneri var. *valida* Doidge 1927: 58 differs from *Puccinia rocherpaniana* in having smaller, thinner-walled urediniospores (see above) and in having narrower teliospores (50–80 x 18–24 µ) with a deep chestnut brown colouration at the apex. The urediniospores of *Puccinia kalchbrenneri* var. *valida* are similar to those of *Puccinia kalchbrenneri*.

Puccinia macowani G. Winter (Winter 1885: 255) and *Puccinia pienaarii* Pole-Evans (Pole Evans 1915: 643) are autoecious, probably demicyclic rust fungi. *Puccinia macowani* differs from *Puccinia rocherpaniana* in having longer and smaller teliospores "60–90 x 19–25 µ" (Doidge 1927). The epispore of the teliospores of *Puccinia pienaarii* is up to 10 µm thick, and has "irregular longitudinal or reticulate ridges or flanges (these is only visible when the spore is dry)" (Doidge 1927).

Puccinia lagenophorae Cooke 1884: 6, which infects several *Helichrysum* species in Australia (Shivas 1989), is autoecious and demicyclic.

Uredo humbertii Maire 1934: 646, described from Madagascar, has bigger urediniospores (40–42 x 34–36 µm).

The attributes of *Puccinia rocherpaniana* are not suitable to any other *Puccinia* species on Asteraceae cited in Doidge (1927). Therefore, the rust fungus is described as new.

The host genus *Helichrysum* belongs to the tribe Gnaphalieae (Herman et al. 2000). With ± 600 species, *Helichrysum* is widespread in Africa (244 species in southern Africa) and Madagascar, as well as in Europe, Asia and Australia.

ASTERACEAE - *LEYSERA*

Aecidium elytropappi Henn. (Hennings 1898: 294). (Fig. 4)

Type on *Elytropappus rhinocerotis* Less. South Africa, 'West-Capland', in the hills behind Bot Rivier, XI.1896, leg. R. Schlechter (B 70 0007271).

Pycnia unknown.

Aecia aecidioid, seriate on stems, covering the whole stem surface over several centimeters, often causing minor hypertrophies of the stems, without leaf spots surrounding aecia, aecial cups conical to cylindrical, erumpent, circa 200–450 µm diameter, up to 1 mm long, spore mass freshly orange to yellow, bleaching in the herbarium to cream-white, surrounded by a recurved, irregularly and deeply frayed peridium. Peridium freshly orange to yellow, bleaching in the herbarium to cream-white, cells of the peridium medium connected, outer wall finely striate, circa 14–16 µm wide, inner wall verrucous, circa 4–7 µm wide. Aeciospores angular globoid, subgloboid to ovoid, 19–27 x 14–22 µm, spore wall about 1–2.5 µm thick, up to 4 µm thick in the edge with the only germ pore, without papillae, finely verrucous, hyaline.

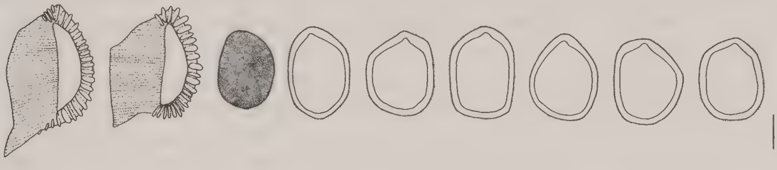

Fig. 4: *Aecidium elytropappi* on *Leysera gnaphalodes*. Peridium cells and aeciospores (RSA 200). Scale bar = 10 µm.

Specimens examined:

- On *Elytropappus rhinocerotis*. South Africa, 'West-Capland', in the hills behind Bot Rivier, XI.1896, leg. R. Schlechter, I (Type B 70 0007271).
- On *Leysera gnaphalodes* (L.) L. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 33.3'', E 18° 18' 37.0'', 21.XI.2001, leg. M. Mennicken No. RSA 25, I (PREM, M).
- On *Leysera gnaphalodes*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 27.0'', E 18° 18' 32.2'', 19.IX.2002, leg. M. Mennicken No. RSA 200, I (PREM, M).

Aecidium elytropappi is denoted on *Elytropappus rhinocerotis* from the Eastern and Western Cape Province in South Africa (Crous, Phillips & Baxter 2000) and on *Stoebe kilimandsharica* O. Hoffm. from Kilimanjaro in Tanzania (Henderson 1972). As far as could be established, *Leysera* is a new host genus. All three known host genera belong to the Gnaphalieae (Herman et al. 2000).

ASTERACEAE - *PTERONIA*

Puccinia pteroniae Mennicken & Oberw. sp. nov. (Fig. 5)

Pycnia et aecia ignota. Uredinia amphigena, subepidermalia, vulpina, usque ad 1 mm diam., mox nuda, pulverulenta. Urediniosporae subgloboideae, pyriformes, ellipsoideae vel oblongae, saepe angulatae, (28–) 33–41 (–48) x 21–33 (–36) µm, pariete echinulato, aureo-fusco, lateraliter (1.5–) 2–2.5 (–3) µm crasso, apicaliter 2–4 µm crasso, 2–4 poris germinationis aequatorialibus. Telia amphigena, subepidermalia, nigra, usque ad 1 mm diam., mox nuda, pulverulenta. Teliosporae bicellulares, subgloboideae, ellipsoideae vel cylindraceae, apice rotundato, base rotundata, medio leviter constrictae, 41–58 (–65) x (28–) 30–40 (–43) µm, pariete laevi, lateraliter 3–6 µm crasso, apicaliter usque ad 9 µm crasso, bilaminato, strato exteriore tenui, luteo-porphyreo, strato interiore atro-porphyreo, poro germinationis cellulae superioris ± apicali vel subapicali, cellulae inferioris ± juxta septum posito, pedicello inflato, dilute aureo-fusco vel hyalino, usque ad 95 µm longo.
In foliis *Pteroniae divaricatae* (Berg.) Less. (Asteraceae).

Pycnia and aecia unknown.

Uredinia amphigenous on leaves, subepidermal, sparse, separate or arranged in irregular groups, single sori round, elliptic or irregular in outline, small, up to 1 mm wide, foxy red, early exposed, pulverulent, surrounded by the torn epidermis, with slightly yellowed and/or brightened leaf spots surrounding uredinia. Urediniospores variable in shape and size, subgloboid, pyriform, ellipsoid or oblong, often somewhat angular, (28–) 33–41 (–48) x 21–33 (–36) µm, echinulate, echinulation coarsely meshed, spores borne singly on pedicels, spore wall about (1.5–) 2–2.5 (–3) µm thick at the sides, about 2–4 µm thick at the apex, golden-brown, germ pores conspicuous, 2 to 4, mostly 3, equatorial, with hyaline papillae that are weakly developed.

Telia amphigenous on leaves, subepidermal, developing from the uredinia, sparse, separate or in irregular groups, single sori roundish or irregular in outline, small, up to 1 mm wide, mostly smaller, black, early exposed, pulverulent, surrounded by the torn epidermis, with slightly yellowed and/or brightened leaf spots surrounding telia. Teliospores bicellular, subgloboid, ellipsoid or cylindrical, rounded above and below, slightly constricted at the septum, 41–58 (–65) x (28–) 30–40 (–43) µm, spore wall smooth, about 3–6 µm thick at the sides, up to 9 µm thick at the apex or over the germ pore, bilaminate, outer layer usually thin-walled, forming preferentially in the range of germ pores large, papilla-like swellings, pale and yellowed mahogany-coloured, inner layer ± uniformly thick-walled, mahogany-coloured to deep mahogany-coloured, germ pore in the upper cell ± apical or 1/3 of the distance from the apex to the septum, in the lower cell below the septum or 1/3 of the distance from the septum to the base, pedicel persistent, up to 95 µm long, not collapsing, short below the attachment with cylindrical, stripe-like inflation, outer margins of the swelling diffusing in Hoyer's fluid, brownish-yellow to hyaline, sometimes obliquely inserted.

On the leaves of *Pteronia divaricata* (Asteraceae).

Etymology. Named after the host plant, *Pteronia divaricata*.

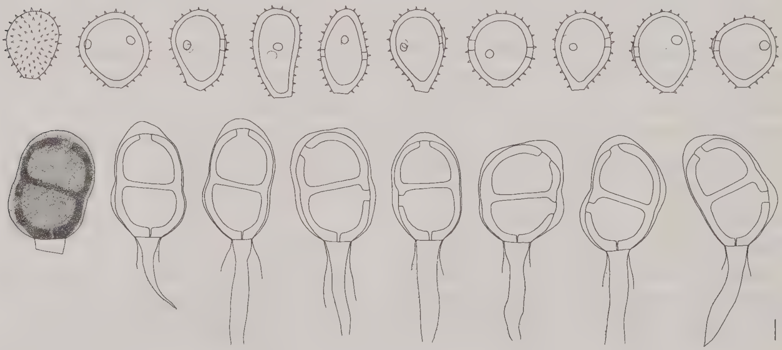

Fig. 5: *Puccinia pteroniae* on *Pteronia divaricata*. Uredinio- and teliospores (RSA 174). Scale bar = 10 µm.

Specimens examined:

- On *Pteronia divaricata*. South Africa, Western Cape Province, BIOTA-observatory at Moedverloren 208, S 31° 27' 43.0'', E 18° 26' 26.1'', 18.IX.2002, leg. M. Mennicken No. RSA 174, II III (Holotype PREM, Isotype M).
- On *Pteronia divaricata*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 24.7'', E 18° 18' 34.7'', 19.IX.2002, leg. M. Mennicken No. RSA 189, II III (Paratypes PREM, M).
- On *Pteronia divaricata*. Namibia, Bezirk Lüderitz, 35 km N of Rosh Pinar (Route to Aus), 2-4 km west of the route, 29.X.1983, leg. B. Leuenberger, Th. Raus & Ch. Schiers No. 3248, II (B 10 9009304).

- On cf. *Pteronia* spec. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 24.5'', E 18° 18' 35.5'', 19.IX.2002, leg. M. Mennicken No. RSA 194, II III (PREM, M).

The host genus *Pteronia*, which belongs to the Astereae, occurs with 70 species mainly in Namibia, Botswana, and South Africa. A few species are extending into Zimbabwe and into Australia (Herman, Retief, Koekemoer & Welman 2000).
As far as could be established, there is no known rust fungus either from the genus *Pteronia* or a similar known rust fungus from other genera of the family Asteraceae in southern Africa or in Australia. Therefore, the rust fungus is described as new.

ASTERACEAE - *SONCHUS*

Miyagia pseudosphaeria Jørst. (Jørstad 1961: 78).
Anamorph. *Aecidium sonchi* Johnst.
Syn. *Puccinia pseudosphaeria* Mont.
Syn. *Puccinia sonchi* Rob. in Desmaziéres 1849: 274. Lectotype on *Sonchus arvensis*, France, autumn.
Syn. *Puccinia pseudo-sphaeria* Mont.
Anamorph. *Aecidium sonchi* Westend. (Westendorp 1861: 649). Type on *Sonchus oleraceus*, Belgium, near Courtrai (HCB No. 1160).
Syn. *Uromyces sonchi* Oudem.
Syn. *Uromyces puccinioides* Fautrey & Rolland in Roumeguére 1893: 25. Type on *Sonchus arvensis*, France, VIII.1892, leg. F. Fautrey.
Syn. *Puccinia tagananensis* Magnus 1901: 297. Type on *Sonchus radiatus* Ait. Teneriffa, near Tagana, VII.1900, leg. Bornmüller.
Syn. *Peristemma sonchi* (Rob.) Syd. (Sydow 1921: 175).
Syn. *Peristemma pseudosphaeria* (Mont.) Jørst. (Jørstad 1956a: 280).
Pycnia and telia not seen. Aecia unknown.
Uredinia amphigenous on leaves, subepidermal, separate or scattered in irregular groups, yellowish pustules small, up to 1 mm wide, long covered by the epidermis, opening through an apical pore, later gaping, pulverulent, spots surrounding pustule up to 2 mm wide, often discoloured violet, not clearly margined on the host leaf. Paraphyses numerous, peripherally surrounding the sori, cylindrical to subclavate, marginally thicker at the apex, pale brown at the base, chestnut-brown at the apex, thick-walled. Urediniospores borne singly on pedicels, ovoid, ellipsoid to oblong ellipsoid, 26–40 x 15–24 μm, echinulate, spore wall about 2–5 μm thick, hyaline, germ pores obscure, only visible in optical sections by the reduced thickness of the spore wall, scattered and probably numerous, without papillae.

Specimens examined:

- On *Sonchus* cf. *oleraceus* L. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 2'3 52.5'', E 18° 16' 49.2'', 08.IX.2002, leg. M. Mennicken No. RSA 125, II (PREM, M).
- On *Sonchus* cf. *oleraceus*. South Africa, Western Cape Province, BIOTA-observatory at Riverlands, S 33° 29' 27.7'', E 18° 35' 25.9'', 19.XI.2001, leg. Markus Göker No. RSA 16, II (PREM, M).
- On *Sonchus* cf. *oleraceus*. South Africa, Western Cape Province, BIOTA-observatory at Moedverloren 208, S 31° 27' 42.2'', E 18° 16' 28.4'', 18.IX.2002, leg. M. Mennicken No. RSA 173, II (PREM, M).

Sonchus cf. *oleraceus* is one of the earliest weeds introduced into South Africa from Europe, having been recorded at the Cape as early as 1685 (Bromilow 2001). As far as could be established, *Miyagia pseudosphaeria* is new to the rust flora of South Africa.

ASTERACEAE - *TARCHONANTHUS*

Uredo tarchonanthi Mennicken & Oberw. sp. nov. (Fig. 6)

Pycnia, aecia et telia ignota. Uredinia abaxialia, subepidermalia, aurantiaca vel ochracea vel cremeo-alba, usque ad 0.2 mm diam., immersa, exposita, pulverulenta, paraphysibus peripheralibus cylindraceis, clavatis, capitatis vel irregularibus, incurvatis, septatis, dilute aureo-brunneis, usque ad 100 µm longis, circa 7–19 µm latis, pariete basali circa 0.5–1 µm crasso, apicali incrassato usque ad 4 µm. Urediniosporae subgloboideae, ovoideae, ellipsoideae, pyriformes vel oblongae, 26–41 (–45) x 17–26 µm, pariete echinulato, dilute aureo-fusco vel hyalino, 1–3 µm crasso.
In foliis *Tarchonanthi littoralis* P.P.J. Herman (Asteraceae).

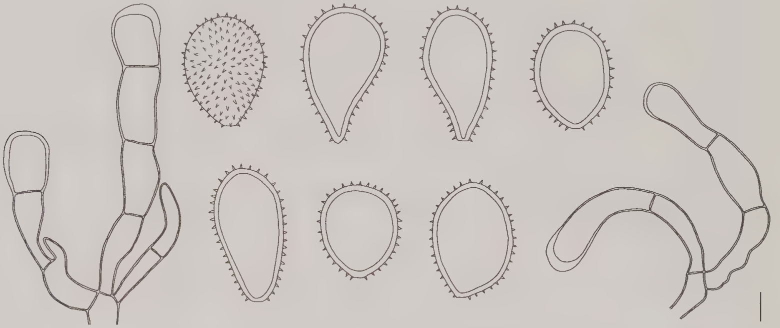

Fig. 6: *Uredo tarchonanthi* on *Tarchonanthus littoralis*. Paraphyses and urediniospores (Holotype RSA 220). Scale bar = 10 µm.

Pycnia, aecia, and telia unknown.
Uredinia abaxial on leaves, scattered, subepidermal, freshly orange and conspicuous, bleaching in the herbarium to ochraceous or cream-white and very inconspicuous as a result of the cream-white, hairy tomentum covering the abaxial leaf surface, single sori strongly immersed, up to 0.2 mm diameter, exposed, pulverulent, surrounded by numerous, mostly incurved paraphyses, paraphyses cylindrical, clavate, or capitate, often irregularly in outline, 1– to 3–septate, up to circa 100 µm long and circa 7–19 µm wide near the apex, wall of the paraphyses about 0.5–1 µm thick basally, up to 4 µm thick near the apex, yellow-brown to hyaline. Urediniospores sessile, subgloboid, ovoid, ellipsoid, pyriform or oblong, 26–41 (–45) x 17–26 µm, grossly echinulate, echinulation closely meshed, spore wall uniformly about 1–3 µm thick, very pale brownish-yellow to hyaline, germ pores obscure, occasionally visible in optical sections, scattered and probably numerous, without papillae.
On the leaves of *Tarchonanthus littoralis* (Asteraceae).
Etymology. Named after the host plant, *Tarchonanthus littoralis*.

Specimen examined:

- On *Tarchonanthus littoralis*. South Africa, Western Cape Province, Cape Peninsula National Park, BIOTA-observatory at Olifantsbos, 23.IX.2002, leg. M. Mennicken No. RSA 220, II (Holotype PREM, Isotype M). Infected with the hyperparasite *Eudarluca caricis* (Biv.) O.E. Erikss.

The genus *Tarchonanthus* forms together with the genus *Brachylaena* the tribe Tarchonantheae and is restricted to Africa, Madagascar and associated islands (Herman, Retief, Koekemoer & Welman 2000). Doidge (1927) described the rust fungus *Uredo brachylaenae* on several *Brachylaena* species in Natal, Transvaal, and Cape Province in South Africa. *Uredo brachylaenae* resembles *Uredo tarchonanthi* in several details like the peripheral, septate paraphyses, and the obscure germ pores. It differs from *Uredo tarchonanthi* in having smaller spores (18–23.5 x 15–17 µm) with a thinner-walled epispore (about 1 µm), and in having "minutely and rather sparsely verruculose-echinulate" spore wall. We examined the type specimens of *Uredo brachylaenae* (Holotype PREM 2525, Paratype PREM 1821, and Paratype PREM 982). Although the urediniospores often have larger dimensions than stated in Doidge (1927), they do not reach the values of our measurements. Furthermore, the echinulate spore wall of *Uredo brachylaenae* is uniformly about 1–1.5 µm thick, the sori are not immersed but superepidermally developed, and the arrangement of the paraphyses is more consolidated in the lower parts of the sorus. Therefore, *Uredo tarchonanthi* is described as new.

ASTERACEAE - *URSINIA*

Puccinia ursiniae R.G. Shivas (Shivas 1991: 379). (Fig. 7)

Type on *Ursinia anthemoides* (L.) Poir. Western Australia, Burns Beach Road, Wanneroo, 20.X.1985, leg. R. G. Shivas (PERTH 791873).

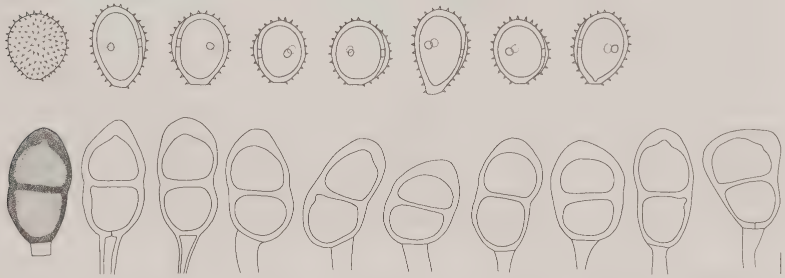

Fig. 7: *Puccinia ursiniae* on *Ursinia anthemoides*. Uredinio- and teliospores (RSA 14). Scale bar = 10 µm.

Pycnia and aecia unknown.

Uredinia mostly amphigenous on leaves, rarely on stems and on peduncles, scattered, single sori round to elliptic in outline, small, up to 1 mm diameter, cinnamon-brown, early exposed, pulverulent, surrounded by the torn epidermis, without leaf spots surrounding uredinia. Urediniospores subgloboid, pyriform, ellipsoid or obovoid, 27–38 x 21–26 µm, echinulate, spores borne singly on pedicels, spore wall about 1.5–2.5 µm thick at the sides, about 2–4 µm thick at the apex, golden-brown to pale brown, germ pores inconspicuous, 3, equatorial, with hyaline papillae that are largely developed.

Telia amphigenous on leaves, on stems, on peduncles and on involucral bracts, (partly) developing from the uredinia, scattered or confluent, single sori on the leaves and on the involucral bracts round to ellipsoid, up to 1 mm diameter, on the stems and the peduncles ellipsoid to oblong, up to 2 mm long, early exposed, cushion-like, pulverulent, surrounded by the torn epidermis, without leaf spots surrounding telia. Teliospores bicellular, ellipsoid or cylindrical, rounded, slightly apiculate or flattened at the apex, rounded or attenuate at the base, not or slightly constricted at the septum, 37–63 x 24–34 µm, spore wall verrucous, with spaced cavities, about 1.5–3 µm thick at the sides, about 5–10 µm thick at the apex, chestnut-brown, germ pore in the upper cell apical, in the lower cell just below the septum, pedicel persistent, up to 120 µm long, thin- or thick-walled, in general not collapsing, hyaline, sometimes obliquely inserted.

Specimens examined:

- On *Ursinia anthemoides*. South Africa, Western Cape Province, BIOTA-observatory at Elandsberg, S 33° 26' 05.8'', E 19° 02' 18.5'', 18.XI.2001, leg. M. Mennicken No. RSA 9, III (PREM, M).
- On *Ursinia anthemoides*. South Africa, Western Cape Province, BIOTA-observatory at Elandsberg, S 33° 26' 01.2'', E 19° 02' 09.8'', 21.IX.2002, M. Mennicken No. RSA 209, II III (PREM, M).
- On *Ursinia anthemoides*. South Africa, Western Cape Province, BIOTA-observatory at Riverlands, S 33° 29' 19.1'', E 18° 35' 20.2'', 19.XI.2001, leg. M. Mennicken No. RSA 14, II III (PREM, M).
- On *Ursinia anthemoides*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 17.2'', E 18° 18' 46.5'', 21.XI.2001, leg. M. Mennicken No. RSA 24, (II) III (PREM, M).

The genus *Ursinia*, which belongs to the Anthemideae, occurs with 39 species in southern Africa and Ethiopia. It is widespread, and especially prominent in Northern Cape (Namaqualand), Western Cape, and the Eastern Cape (Herman et al. 2000). *Ursinia anthemoides* has been introduced in Australia and "has become a weed of roadsides and waste places on a variety of soils extending throughout the south-western region of the State" (Marchant et al. 1987 in Shivas 1991).

Our collections agree well with the diagnosis of *Puccinia ursiniae* given by Shivas (1991). The type collection is from Western Australia, but Shivas (1991) checked the possibility that *Puccinia ursiniae* was indigenous to South Africa. He found that eight of 26 herbarium specimens of *Ursinia anthemoides* received from South Africa were infected with *Puccinia anthemoides*. The oldest South African specimen of *Ursinia anthemoides* infected with *Puccinia ursiniae* was collected in the year 1885.

CHENOPODIACEAE - *SALSOLA*

Uredo sp. (Fig. 8)

Pycnia, aecia and telia unknown or not seen, respectively.

Uredinia amphigenous on the elongated leaves of spherical, small, up to 1,5 cm wide, gall-shaped concrescences, subepidermal, scattered, irregularly rupturing pustules up to 1 mm wide, roundish or elliptic, cinnamon-brown, without spots surrounding pustules, early exposed and surrounded by the torn epidermis. Urediniospores subgloboid, pyriform, ellipsoid or terete, 24–32 (–34) x 19–24 (–26) µm, echinulate, spores borne singly on pedicels, spore wall uniformly about 1.5–2.5 µm thick, golden to pale chestnut-brown, germ pores 3 to 6, scattered, with hyaline papillae.

Specimens examined:

- On *Salsola* cf. *zeyheri* (Moq.) Bunge. South Africa, Western Cape Province, BIOTA-observatory at Moedverloren 208, S 31° 27' 42.3'', E 18° 26' 28.4'', 18.IX.2002, leg. M. Mennicken No. RSA 170, II (PREM, M).
- On *Salsola* cf. *zeyheri*. South Africa, Western Cape Province, BIOTA-observatory at Moedverloren 208, S 31° 27' 42.3'', E 18° 26' 30.6'', 18.IX.2002, leg. M. Mennicken No. RSA 182, II (PREM, M).

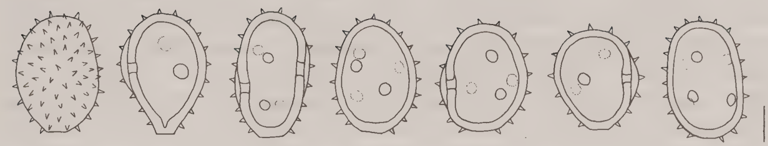

Fig. 8: *Uredo* sp. on *Salsola* cf. *zeyheri*. Urediniospores (RSA 170). Scale bar = 10 µm.

As far as could be established, there is no known South African rust fungus on *Salsola*. Because of the existence of several *Uromyces* species with similar urediniospore dimensions on Chenopodiaceae (Sydow & Sydow 1910) our results are inconclusive.

FABACEAE - *ASPALATHUS*

Uredo aspalathi Mennicken & Oberw. sp. nov. (Fig. 9)

Pycnia, aecia et telia ignota. Uredinia amphigena, subepidermalia, cinnamomea, usque ad 1 mm diam., mox nuda, pulverulenta. Urediniosporae globoideae, pyriformes vel late ellipsoideae, 24–32 x 22–27 µm, pariete echinulato, aureo-fusco, 2.5–3.5 µm crasso, 4–6 poris germinationis dispersis.
In foliis *Aspalathi laricifoliae* Bergius (Fabaceae)

Pycnia, aecia, and telia unknown.

Uredinia amphigenous on leaves, subepidermal, forming small prominent pustules, up to 1 mm wide, roundish or elliptic, irregularly rupturing, cinnamon-brown, without spots surrounding pustules, clearly margined on the host leaves, surrounded by the torn epidermis. Urediniospores borne singly on short pedicels, globoid, pyriform or (broadly) ellipsoid, partially tending to be triangular to pentagonal with broadly rounded edges, 24–32 x 22–27 µm, echinulate, echinulation coarsely and irregularly meshed, spore wall uniformly about 2.5–3.5 µm thick, golden to dark golden-brown, germ pores conspicuous, 4 to 6, scattered, with hyaline papillae.

On the leaves of *Aspalathus laricifolia* (Fabaceae).

Etymology. Named after the host plant, *Aspalathus laricifolia.*

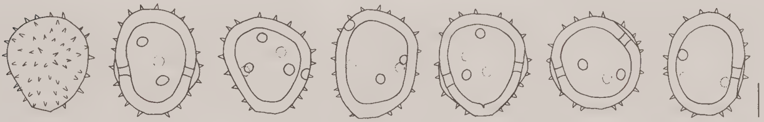

Fig. 9: *Uredo aspalathi* on *Aspalathus laricifolia*. Urediniospores (Holotype RSA 2). Scale bar = 10 µm.

Specimens examined:

- On *Aspalathus laricifolia*. South Africa, Western Cape Province, Cape Peninsula National Park, BIOTA-observatory at Olifantsbos, S 34° 15’ 46.1’’, E 18° 23’ 36.6’’, 17.XI.2001, leg. M. Mennicken No. RSA 2, II (Holotype PREM, Isotype M).
- On *Aspalathus laricifolia*. South Africa, Western Cape Province, Cape Peninsula National Park, BIOTA-observatory at Olifantsbos, S 34° 15’ 40.3’’, E 18° 23’ 35.5’’, 23.IX.2002, leg. M. Mennicken No. RSA 215, II (Paratypes PREM, M).

The genus *Aspalathus*, which belongs to the subfamily Papilionideae and the tribe Crotalarieae is with ± 278 species the largest genus of flowering plants endemic in southern Africa (Germishuizen 2000). The center of distribution is in the Western Cape but extends into KwaZulu-Natal.

As far as could be established, only microcyclic rust fungi have been described on *Aspalathus* so far: *Uromyces bolusii* Massee 1901: 168 (Type on *Aspalathus pachyloba* Benth., South Africa, Montagu Bath, leg. Bolus No. 7597), and *Uromyces ventosa* (as *Teleutospora ventosa*) Syd. (Sydow 1924: 235) (Type on *Aspalathus* sp. (as *Borbonia* sp.), South Africa, Stellenbosch, VIII.1923, leg. A. V. Duthie No. 1246).

FABACEAE - *LEBECKIA*

Aecidium dielsii Henn. (Hennings 1904: 34). (Fig. 10)

Type on *Crotalaria* sp. South Africa, Clanwillian, 1900, leg. Diels No. 1145 (B).

Pycnia unknown.

Aecia aecidioid, amphigenous on leaves, on flowers, and on stems, covering the whole stem surface over several centimeters, often causing hypertrophy of the stems, without spots surrounding aecia, aecial cups reduced to salient, erumpent pustules, circa 400–500 µm diameter, spore mass orange, yellow to cream-white, peridium exserted, slit right to the base in narrow segments, yellowish to cream-white, up to 2.2 cm long, cells of the peridium medium connected, oblong, outer wall striate, circa 3–7 µm wide, inner wall inconspicuously striate, circa 1.5–3 µm wide. Aeciospores angular globoid, subgloboid, ellipsoid to oblong, 22–33 x 18–26 µm, spore wall about 2–4 µm thick, up to 5.5 µm thick in one edge, finely verrucous, yellowish to hyaline, germ pores normally invisible, partly visible in optical sections, probably scattered and numerous, without papillae.

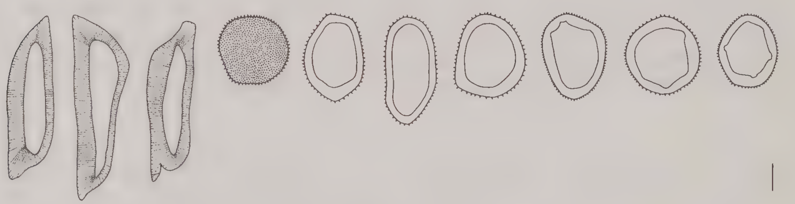

Fig. 10: *Aecidium dielsii* on *Lebeckia* sp. Peridium cells and aeciospores (RSA 185). Scale bar = 10 µm.

Specimen examined:

- On Lebeckia sp. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36’ 32.9’’, E 18° 18’ 23.1’’, 19.IX.2002, leg. M. Mennicken No. RSA 185, I (PREM, M).

Our collection agrees well with the diagnosis of *Aecidium dielsii.* As far as could be established, *Aecidium dielsii* is known only from the type collection on *Crotalaria* sp. Thus, *Lebeckia* could be proven as a new host genus. Both host genera belong to the tribe Crotalarieae in Papilionoideae (Germishuizen 2000).

FABACEAE - *PSORALEA*

cf. ***Phakopsora pachyrhizae*** Syd. & P. Syd. (Sydow & Sydow 1914: 108).

Type on *Pachyrhizus angulatus* Rich. Formosa, Taihoku, 25.XII.1913, leg. Y. Fujikuro No. 37. For synonyms and figures see Ono, Buriticá & Hennen (1992).

Pycnia and aecia unknown. Telia not seen.

Uredinia amphigenous on leaves, subepidermal, separate or scattered, pustules small, up to 0.25 mm diameter, roundish, pale brown, opening through a central aperture, pulverulent, not clearly margined on the host leaves, spots surrounding pustule up to 1 cm wide, roundish or irregularly in outline, discoloured brown to dark brown, not clearly margined at the host leaves, single sori surrounded by paraphyses arising from peridioid pseudoparenchyma, also with hymenial paraphyses, paraphyses cylindrical to clavate, up to 45 µm long and up to 12 µm wide apically, wall of the paraphyses thin at the sides, up to 11 µm thick at the apex, pale golden to hyaline. Urediniospores subgloboid, obovoid, pyriform to ellipsoid, 20–28 (–32) x 13–18 µm, echinulate, spore wall uniformly about 1 µm thick, pale yellowish-brown to hyaline, germ pores rather obscure, probably 2 to 8, scattered or ± equatorial, without or with hyaline papillae that are very weakly developed.

Specimen examined:

- On *Psoralea pinnata* L. South Africa, Western Cape Province, Kirstenbosch Botanical Garden, 29.IX.2002, leg. M. Mennicken No. RSA 221, II (PREM, M).

According to Ono, Buriticá & Hennen (1992), *Phakopsora pachyrhizi* infects a wide range of Leguminosae in Austro-Asia and Africa. Without teliospores *Phakopsora pachyrhizi* can not be delimited from *Phakopsora meibomiae* (Arthur) Arthur 1917: 509 (Syn. *Phakopsora psoraleae* Jackson 1931: 346. Type on *Psoralea glandulosa* L. Bolivia, Sorata). *Phakopsora meibomiae* attacks several Leguminosae in the New World. Because of the geographic origin of our collection from South Africa, we refer to this rust fungus as *Phakopsora pachyrhizae*. As far as could be established *Psoralea* seems to be a new host genus for *Phakopsora pachyrhizi*.

GERANIACEAE - *PELARGONIUM*

Puccinia granularis Kalchbr. & Cooke in Kalchbrenner 1882: 22.

Type on *Pelargonium* sp. South Africa, P. Natal, No. 10.

Anamorph. *Aecidium pelargonii* Thüm. (Thümen 1877: 411). Type on *Pelargonium alchemilloides* Willd. South Africa, Boschberg near Somerset-East, Promont, XI.1876, leg. MacOwan.

Anamorph. *Uredo pelargonii* Thüm. (Thümen 1878: 355). Type on *Pelargonium alchemilloides*. South Africa, Boschberg near Somerset-East, Promont, XI.1876, leg. MacOwan.

Syn. *Puccinia pelargonii* (Thüm.) P. Syd. & Syd. (Sydow & Sydow 1904: 469).

Pycnia, aecia, and telia not seen.

Uredinia abaxial on leaves, separate, scattered or in irregularly crowded groups, reddish-brown, forming round or irregular shaped sori on indefinite leaf spots, early exposed, pulverulent, surrounded by the torn epidermis. Urediniospores globoid, subgloboid, or ellipsoid, 24–29 x 21–24 µm, echinulate, spores borne singly on pedicels, spore wall uniformly about 2.5–3.5 µm thick, golden-brown, germ pores 2 (to 3), equatorial, without papillae.

Specimen examined:

- On *Pelargonium grossularioides* (L.) L'Hér. South Africa, Western Cape Province, BIOTA-observatory at Elandsberg, S 33° 26' 03.2'', E 19° 02' 23.5'', 18.XI.2001, leg. M. Mennicken No. RSA 10, II (PREM, M).

Our collection agrees well with the description of *Puccinia granularis* given by Doidge (1927). In South Africa one collection of *Puccinia granularis* on *Pelargonium grossularioides* is known from the Western Cape Province, University of Cape Town grounds, 31.IV.1934, leg. J.P.H. Acocks No. 2443 (Jørstad 1956b). This collection is not mentioned in Crous, Philip & Baxter (2000).

LAMIACEAE - *MENTHA*

Puccinia menthae Pers.

For synonyms see Sydow & Sydow (1904).

Pycnia, aecia, and telia not seen.

Uredinia abaxial on leaves, on stems, subepidermal, pale cinnamon-brown, separate, scattered, or arranged in irregular or concentric groups, single sori roundish, ellipsoid, or irregularly in outline, up to 1 mm diameter, first covered by the epidermis, early exposed, pulverulent, surrounded by the torn epidermis, mostly with yellowed, brightened or browned leaf spots surrounding uredinia. Urediniospores globoid, subgloboid, or ellipsoid, 22–29 x 18–22 µm, finely echinulate, spores borne singly on pedicels, spore wall uniformly about 1–2 µm thick, pale golden-brown to hyaline, germ pores inconspicuous, 2 to 3, ± equatorial, occasionally one additional apical germ pore, with hyaline papillae that are weakly developed.

Specimen examined:

- On *Mentha* cf. *longifolia* (L.) L. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 23' 53.8'', E 18° 16' 51.5'', 08.IX.2002, leg. M. Mennicken No. RSA 127, II (PREM, M).

Puccinia menthae, which is known from the provinces Gauteng and KwaZulu-Natal in South Africa (Crous, Phillips & Baxter 2000), seems to be new to the rust flora of Northern Cape.

ORCHIDACEAE - *BARTHOLINA*

Uromyces silksvleyensis Mennicken & Oberw. sp. nov. (Fig. 11)

Pycnia, aecia et uredinia ignota. Telia in foliis, plurimum abaxialia, raro adaxialia vel in petiolis, subepidermalia, nigro-brunnea, usque ad 1.2 mm diam., epidermide diu tecta, pulverulenta. Teliosporae unicellulares, globoideae, subgloboideae vel ellipsoideae, apice rotundato, leviter acuto vel leviter applanato, base rotundata vel leviter attenuata, 26–36 x 23–29 (–33) µm, pariete laevigato, castaneo, lateraliter 0.5–1.5 µm crasso, apicaliter 3–4 (–5) µm crasso, poris germinationis inconspicuis, pedicello dilute aureo vel hyalino, usque ad 35 µm longo.
In foliis cf. *Bartholinae burmannianae* Ker-Gawl. (Orchidaceae).

Pycnia, aecia, and uredinia unknown.

Telia abaxial on leaves, occasionally adaxial, on petioles, scattered in confluent groups which can cover the whole leaf surface, subepidermal, single sori roundish, ellipsoid or irregularly in outline, up to 1.2 mm diameter, dark chocolate-brown to black, long covered by the epidermis which ruptures lately but always partly veiled, compact, pulverulent, without leaf spots surrounding telia. Teliospores unicellular, globoid, subgloboid to ellipsoid, often somewhat angular and irregularly, occasionally broader than long, rounded, slightly flattened, or slightly acute at the apex, rounded or slightly attenuate at the base, 26–36 x 23–29 (–33) µm, spore wall smooth, about 0.5–1.5 µm thick at the sides, about 3–4 (–5) µm thick at the apex, becoming progressively thicker from the base towards the apex, widest thickness not inevitably in the opposite of the pedicel, often obliquely displaced, chestnut-brown, germ pore obscure, probably apical, pedicel persistent, up to 35 µm long, thin-walled, collapsing, yellowish to hyaline, sometimes obliquely inserted.

On the leaves and petioles of cf. *Bartholina burmanniana* (Orchidaceae).

Etymology. Named after the neighbouring field name, Silksvley.

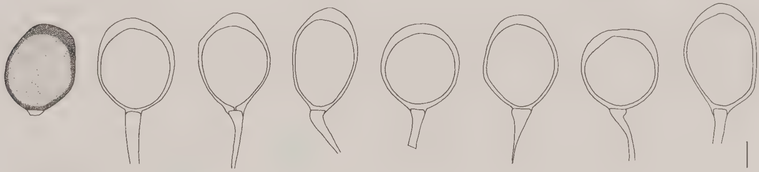

Fig. 11: *Uromyces silksvleyensis* on cf. *Bartholina burmanniana*. Teliospores (Holotype RSA 218). Scale bar = 10 µm.

Specimen examined:

- On cf. *Bartholina burmanniana*. South Africa, Western Cape Province, Cape Peninsula National Park, BIOTA-observatory at Olifantsbos, S 34° 15' 54.3'', E 18° 24' 03.2'', 23.IX.2002, leg. M. Mennicken No. RSA 218, III (Holotype PREM, Isotype M).

As far as could be established, there is neither a known *Uromyces* species on Orchidaceae in southern Africa nor is there any known *Uromyces* species on the host genus *Bartholina*, which, with two species, is endemic to southern Namibia, and to Northern, to Western and to Eastern Cape (Kurzweil 2000). Therefore, the rust fungus is described as new.

POACEAE - *BROMUS*

Puccinia hordei G.H. Otth.

For synonyms and figures see Cummins (1971).

Pycnia and aecia not seen.

Uredinia mostly adaxial on leaves, creamish-white to ochraceous, subepidermal, forming long streaks between the nerves of the leaves, early exposed, pulverulent, surrounded by the torn epidermis. Urediniospores globoid, subgloboid, ovoid, pyriform or ellipsoid, 21–33 (–39) x 19–29 µm, finely echinulate, spores borne singly on pedicels, spore wall uniformly about 1–2.5 µm thick, pale yellowish, pale brownish to hyaline, germ pores inconspicuous, 10 to 15, scattered, with hyaline papillae that are weakly developed.

Telia amphigenous on leaves, mostly abaxial, and on sheaths, dark chocolate-brown to blackish, forming long, confluent streaks between the nerves of the leaves, long remaining covered by the epidermis which later longitudinally ruptures, loculate by brown, palisade-wise paraphyses, compact. Teliospores bicellular, variable in shape and size, ellipsoid, clavate, oblong or irregularly in outline, often angular, rounded, acuminate or flattened at the apex, rounded or attenuate at the base, slightly constricted at the septum, (30–) 36–63 x 17–32 (–36) µm, spore wall smooth or with longitudinal surface ridges, about 1–2 µm thick at the sides, about 3–9 µm thick at the apex, yellow-brown to chestnut-brown, mostly paler towards the base, often paler towards the apex, germ pores obscure, pedicel persistent, up to 20 µm long, often truncate immediately below the attachment, thin-walled, collapsing, yellowish to hyaline, often obliquely inserted. Mesospores and tricellular spores existing.

Specimens examined:

- On *Bromus pectinatus* Thunb. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 23' 47.5'', E 18° 16' 45.3'', 27.XI.2001, leg. M. Mennicken No. RSA 67, II III (PREM, M).
- On *Bromus pectinatus*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 30.8'', E 17° 33' 11.9'', 11.IX.2002, leg. M. Mennicken No. RSA 137, II III (PREM, M).
- On *Bromus pectinatus*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 31.0'', E 17° 32' 55.7'', 11.IX.2002, leg. M. Mennicken No. RSA 142, II III (PREM, M).
- On *Bromus pectinatus*. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 23' 49.3'', E 18° 16' 43.4'', 27.XI.2001, leg. M. Mennicken No. RSA 69, II III (PREM, M).
- On *Bromus pectinatus*. South Africa, Western Cape Province, BIOTA-observatory at Flaminkvlakte 111, S 31° 17' 07.1'', E 18° 35' 46.6'', 06.IX.2002, leg. M. Mennicken No. RSA 116, II (PREM, M).
- On *Bromus pectinatus*. South Africa, Western Cape Province, BIOTA-observatory at Moedverloren 208, S 31° 27' 48.0'', E 18° 26' 31.4'', 05.IX.2002, leg. M. Mennicken No. RSA 113, II III (PREM, M).
- On *Bromus pectinatus*. South Africa, Western Cape Province, BIOTA-observatory at Luiperskop 211, S 31° 17' 37.1'', E 18° 36' 14.6'', 07.IX.2002, leg. M. Mennicken No. RSA 118, II III (PREM, M).
- On *Bromus pectinatus*. South Africa, Western Cape Province, BIOTA-observatory at Luiperskop 211, S 31° 17' 30.7'', E 18° 36' 04.0'', 23.XI.2001, leg. M. Mennicken No. RSA 35, III (PREM, M).
- On *Bromus pectinatus*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 28.8'', E 18° 18' 29.9'', 19.IX.2002, leg. M. Mennicken No. RSA 201, II III (PREM, M).

Puccinia hordei agrees well with the description given in Cummins (1971). As far as could be established, there is only one collection of *Puccinia hordei* (on *Bromus pectinatus)* in South Africa (Gjærum 1988). This collection is not mentioned in Crous, Phillips & Baxter (2000). In South Africa the host plant *Bromus pectinatus* is regarded as an exotic plant from Eurasia (Bromilow 2001).

POACEAE - *CHAETOBROMUS*

Uromyces chaetobromi Gjærum 1988: 371. (Fig. 12)

Type on *Chaetobromus schraderi* Stapf. South Africa, Cape Province, Clanwillian distr. (as Chanwillian distr.), 07.XI.1974, leg. Van Breda No. 4302 (Holotype K, Isotype NPPI).

Pycnia and aecia unknown.

Uredinia amphigenous on leaves, subepidermal, cinnamon-brown, forming small elliptic to oblong, later confluent patches between the nerves of the leaves, early exposed, pulverulent, surrounded by the torn epidermis. Urediniospores globoid, subgloboid or ellipsoid, 24–33 x 22–31 µm, echinulate, spores borne singly on pedicels, spore wall uniformly about 2–2.5 (–3) µm thick, yellow-brown, germ pores 6 to 12, scattered, with hyaline papillae that are weakly developed.

Telia amphigenous on leaves, subepidermal, blackish, (partly) developing from the uredinia, forming small elliptic to oblong patches, long covered by the epidermis, later-exposed, compact to cushion-like, surrounded by the torn epidermis. Teliospores unicellular, 21–31 x 18–27 µm, irregularly in shape, mostly angular globoid, subgloboid to ellipsoid, sometimes broader than long, rounded, acute or flattened at the apex, rounded or attenuate at the base, chestnut-brown, spore wall smooth, about 1–2 µm thick at the sides, about 3–7 µm thick at the apex, germ pore apical, pedicel persistent, up to 55 µm long, thin-walled, collapsing, yellow-brownish to hyaline, often obliquely inserted.

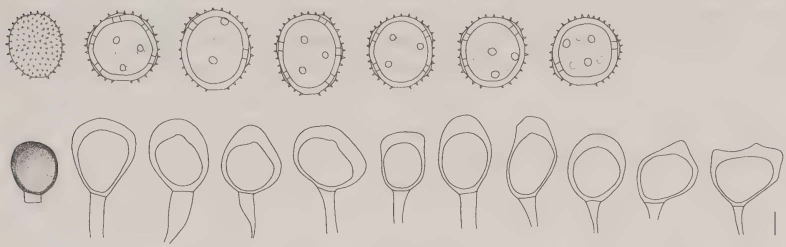

Fig. 12: *Uromyces chaetobromi*. Uredinio- and teliospores on *Chaetobromus dregeanus* (RSA 135). Scale bar = 10 µm.

Specimens examined:

- On *Chaetobromus dregeanus* Nees. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 23' 53.9'', E 18° 16' 49.7'', 08.IX.2002, leg. M. Mennicken No. RSA 126, II (PREM, M).
- On *Chaetobromus dregeanus*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 31.0'', E 17° 32' 45.4'', 11.IX.2002, leg. M. Mennicken No. RSA 135, II III (PREM, M).
- On *Chaetobromus dregeanus*. South Africa, Western Cape Province, BIOTA-observatory at Moedverloren 208, S 31° 27' 40.5'', E 18° 26' 30.5'', 05.IX.2002, leg. M. Mennicken No. RSA 102, II III (PREM, M).

Our collections agree well with the characteristics of *Uromyces chaetobromi* given in the diagnosis (Gjærum 1988). No uredinia but only urediniospores were described from the type collection. The number of germ pores of the urediniospores is wider in our collections (6 to 12) compared to the type collection (7 to 8). As far as could be established, *Uromyces chaetobromi* is only known from the type collection. The type collection is not mentioned in Crous, Phillips & Baxter (2000). *Chaetobromus dregeanus* seems to be a new host plant.

POACEAE - *EHRHARTA*

Uromyces ehrhartae-giganteae Doidge 1927: 207 emend. (Fig. 13)

Type on *Ehrharta thunbergii* Gibbs Russell (= *E. gigantea* Thunb.), South Africa, Mobray, Cape Province, 10.II.1914, leg. Van der Merve No. 7392.

Anamorph. *Uredo ehrhartae-calycinae* Doidge 1948: 907. Type on *Ehrharta calycina* J.E. Sm. South Africa, Stellenbosch, leg. Verwoed, Herb. Stell. Elsenburg Coll. Agric. 41 (34098).

Pycnia and aecia unknown.

Uredinia amphigenous on leaves, mostly adaxial, cinnamon-brown, forming long and narrow, later confluent streaks between the nerves of the leaves, early exposed, pulverulent, surrounded by the torn epidermis. Urediniospores globoid, pyriform or broadly obovoid, 20–31 x 19–26 µm, echinulate, spores borne singly on pedicels, spore wall uniformly about 2.5–4 µm thick, golden to chestnut-brown, germ pores 6 to 8, scattered, with inconspicuous, hyaline papillae that are weakly to broadly developed.

Telia mostly adaxial on leaves, rarely abaxial, on sheaths or stems, dark chocolate-brown, forming patches and long, confluent streaks, exposed, cushion-like, surrounded by the torn epidermis. Teliospores unicellular, 26–43 (–46) x 19–32 µm, tending to be dimorphic with broadly ellipsoid or globoid spores that are mostly more than 25 µm broad and ellipsoid or oblong-ellipsoid spores that are mostly less than 25 µm broad, occasionally asymmetrically angular, golden-brown to chestnut-brown, rounded, flattened or acute at the apex, rounded or attenuate at the base, spore wall smooth, about 1–4 µm thick at the sides, up to 12 µm thick at the apex, germ pore apical, pedicel persistent, up to 170 µm long, not collapsing, yellow-brownish to hyaline, thick-walled, pedicel wall about 1.5–3 µm thick.

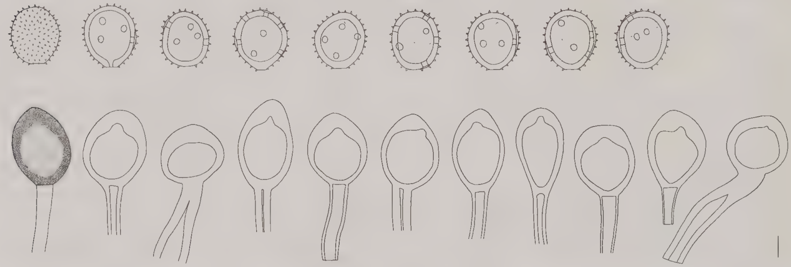

Fig. 13: *Uromyces ehrhartae-giganteae*. Uredinio- and teliospores on *Ehrharta villosa* (RSA 190). Scale bar = 10 µm.

Specimens examined:

- On *Ehrharta calycina*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36’ 26.6’’, E 18° 18’ 32.0’’, 19.IX.2002, leg. M. Mennicken No. RSA 192, II (PREM, M).
- On *Ehrharta villosa* Schult. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36’ 33.8’’, E 18° 18’ 22.4’’, 19.IX.2002, leg. M. Mennicken No. RSA 190, II III (PREM, M).
- On *Ehrharta villosa*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36’ 15.6’’, E 18° 18’ 37.6’’, 21.XI.2001, leg. M. Mennicken No. RSA 20, III (PREM, M).

The urediniospores of our collections agree well with the specifications of *Uredo ehrhartae-calycinae*, which are given in the diagnosis and revised by Cummins (1971): (20–) 22–27 (–29) µm x (17–) 19–21 µm and (4 to) 5 to 8 scattered germ pores. Only the maximum broadness of the urediniospores is 5 µm more in our collections.

Our teliospores coincide with the dimorphic characteristic of *Uromyces ehrhartae-giganteae*, but they reach a larger size than in the diagnosis (Doidge 1927) or in the description of Cummins (1971), respectively. Cummins (1971) scaled up the size of the teliospores given in the diagnosis and specifies for the type: “spores (23–) 26–36 (–38; 40) x (16–) 19–24 (–26) µm”.

Summarizing, the deviation in the maximum broadness of the urediniospores and in the size of the teliospores does not justify a new species, all the more so, as the habitats are close-by, and the teliospores were found on a host plant different from the host of the type collection. We assume that our collections belong to *Uromyces ehrhartae-giganteae*, which is synonymous with *Uredo ehrhartae-calycinae*. *Ehrharta villosa* seems to be a new host plant for this rust fungus.

Uromyces quaggafonteinus Mennicken & Oberw. sp. nov. (Fig. 14)

Pycnia et aecia ignota. Uredinia amphigena, subepidermalia, vulpina, mox nuda, pulverulenta. Urediniosporae globoideae vel late ellipsoideae, 26–36 x 24–32 µm, pariete echinulato, luteo-fusco vel dilute castaneo, 2.5–4 µm crasso, 5–9 poris germinationis dispersis. Telia amphigena, subepidermalia, nigro-brunnea, mox nuda, pulvinata. Teliosporae unicellulares, globoideae vel subellipsoideae, apice rotundato, leviter acuto vel leviter applanato, base rotundata, 28–39 x 24–32 µm, pariete laevigato, castaneo, lateraliter 2–4 µm crasso, apicaliter usque ad 12 µm crasso, poro germinationis apicali, pedicello dilute aureo-fusco vel hyalino, usque ad 140 µm longo.
In foliis *Ehrhartae calycinae* J.E. Sm. (Poaceae).

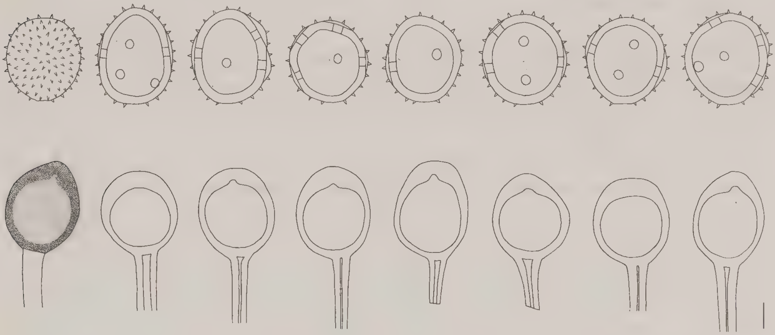

Fig. 14: *Uromyces quaggafonteinus*. Uredinio- and teliospores on *Ehrharta calycina* (Paratype RSA 49). Scale bar = 10 µm.

Pycnia and aecia unknown.
Uredinia amphigenous on leaves, subepidermal, foxy red, forming small, elliptic to oblong, later confluent patches between the nerves of the leaves, early exposed, pulverulent, surrounded by the torn epidermis. Urediniospores globoid or broadly ellipsoid, golden to pale chestnut-brown, 26–36 x 24–32 µm, echinulate, borne singly on pedicels, spore wall uniformly about 2.5–4 µm thick, germ pores 5 to 9, scattered, with inconspicuous, hyaline or yellowish papillae that are weakly developed.
Telia amphigenous on leaves, subepidermal, dark chocolate-brown, forming small, elliptic to oblong, later confluent patches, between the nerves of the leaves, exposed, cushion-like, surrounded by the torn epidermis. Teliospores unicellular, globoid to subelliptic, rounded, slightly flattened or slightly acute at the apex, rounded at the base, 28–39 x 24–32 µm, chestnut-brown, spore wall smooth, about 2–4 µm thick at the sides, up to 12 µm thick at the apex, germ pore apical, pedicel persistent, up to 140 µm long, not collapsing, brownish-yellow to hyaline, thick-walled, pedicel wall up to 3 µm thick, occasionally obliquely inserted.
On the leaves of *Ehrharta calycina*. (Poaceae)
Etymology. Named after the collection site, Quaggafontein.

Specimens examined:

- On *Ehrharta calycina*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 31.1'', E 17° 32' 55.6'', 11.IX.2002, leg. M. Mennicken No. RSA 139, II III (Holotype PREM, Isotype M).

- On *Ehrharta calycina*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 25.9'', E 17° 32' 53.0'', 26.XI.2001, leg. M. Mennicken No. RSA 49, II III (Paratypes PREM, M).

Uromyces quaggafonteinus differs from *Uromyces ehrhartae-giganteae* (see above) in the lack of oblong-ellipsoid or asymmetrical angular teliospores. The mean length of the teliospores is shorter, the mean broadness of the teliospores is wider, the echinulation of the urediniospores is coarser and the size of the urediniospores is bigger than in *Uromyces ehrhartae-giganteae*. Only with teliospores a precise determination of these two rust fungi is not possible.

POACEAE - *HOLCUS, KARROOCHLOA, SCHISMUS, TRIBOLIUM*
Uromyces holci Jørst. (Jørstad 1956b: 577). (Fig. 15)
Type on *Holcus setiger* Nees, South Africa, Northern Cape Province, between Pedroskloff and Leliefontein, leg. Drege (S).
Syn. *Uromyces schismi* Jørst. (Jørstad 1956b: 577). Type on *Schismus scaberrimus* Nees, locality unknown "but the collection is obviously from S. Africa, where the host belongs".

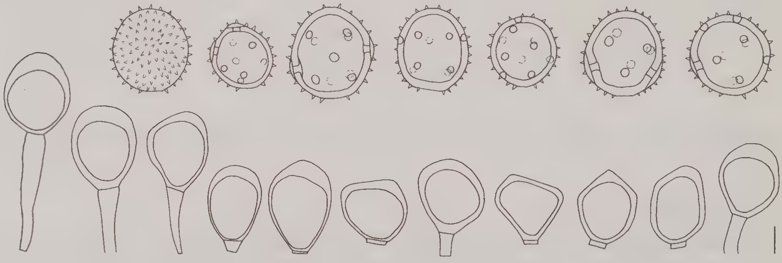

Fig. 15: *Uromyces holci*. Uredinio- and teliospores. Scale bar = 10 µm.

Pycnia and aecia unknown.

Uredinia adaxial on leaves, foxy red, forming patches and stripes between the nerves of the leaves, early exposed, surrounded by the torn epidermis. Urediniospores globoid, broadly ovoid, or broadly ellipsoid, golden to pale chestnut-brown, 21–31 (–34) x 18–28 µm, finely echinulate, spores borne singly on pedicels, spore wall uniformly about 1.5–2.5 (–3) µm thick, germ pores 7 to 11, scattered, with hyaline papillae.

Telia adaxial on leaves, blackish, forming small, later confluent patches, early exposed, cushion-like, surrounded by and arched over by the torn epidermis. Teliospores unicellular, variable in shape and size, 19–33 x 15–29 µm, dimorphic with broadly ellipsoid or globoid spores tending to be chestnut-brown and with globoid, ellipsoid or oblong-ellipsoid, asymmetrically angular, variable spores tending to be golden to pale chestnut-brown, spore wall smooth, about 1–3 µm thick at the sides, about 2–8 µm thick at the apex, germ pore apical, pedicel persistent, up to 80 µm long, brownish-yellow, thick-walled and predominantly not collapsing in the chestnut-brown spores, thin-walled and collapsing in the golden to pale chestnut-brown spores.

Specimens examined:

- On cf. *Holcus setiger* Nees. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 17.4'', E 18° 18' 45.3'', 21.XI.2001, leg. M. Mennicken No. RSA 23, II III (PREM, M).
- On cf. *Holcus setiger*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 32.5'', E 18° 18' 38.6'', 21.XI.2001, leg. M. Göker No. RSA 26, II III (PREM, M).
- On *Karroochloa* cf. *schismoides* (Stapf ex Conert) Conert & Tuerpe. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 23.0'', E 17° 33' 06.2'', 26.XI.2001, leg. M. Mennicken No. RSA 51, II III (PREM, M).
- On *Schismus barbatus* (Loefl. ex L.) Thell. Namibia, Lüderitz-Süd, Farm Spitzkop LUS, 2716 DC, 25.IX.1977, leg. H. Merxmüller & W. Giess, II III (WIND 46700).
- On *Schismus barbatus*. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 23' 49.7'', E 18° 16' 44.2'', 27.XI.2001, leg. M. Mennicken No. RSA 66, II (PREM, M).
- On *Schismus barbatus*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 22.8'', E 17° 33' 13.0'', 26.XI.2001, leg. M. Mennicken No. RSA 50, II III (PREM, M).
- On *Schismus barbatus*. South Africa, Northern Cape Province, BIOTA-observatory at Leliefontein 624, S 30° 23' 36.2'', E 18° 16' 35.8'', 27.XI.2001, leg. M. Mennicken No. RSA 57, II III (PREM, M).
- On *Schismus barbatus*. South Africa, Northern Cape Province, BIOTA-observatory at Leliefontein 624, S 30° 23' 36.4'', E 18° 16' 37.6'', 27.XI.2001, leg. M. Mennicken No. RSA 58, II III (PREM, M).
- On *Schismus barbatus*. South Africa, Western Cape Province, BIOTA-observatory at Flaminkvlakte 111, S 31° 17' 05.1'', E 18° 35' 48.8'', 23.XI.2001, leg. M. Mennicken No. RSA 30, II III (PREM, M).
- On *Schismus barbatus*. South Africa, Western Cape Province, BIOTA-observatory at Luiperskop 211, S 31° 17' 35.4'', E 18° 36' 04.0'', 23.XI.2001, leg. M. Mennicken No. RSA 36, II III (PREM, M).
- On *Schismus barbatus*. South Africa, Western Cape Province, BIOTA-observatory at Moedverloren 208, S 31° 27' 40.1'', E 18° 26' 31.6'', 05.IX.2002, leg. M. Mennicken No. RSA 103, II III (PREM, M).
- On *Schismus barbatus*. South Africa, Western Cape Province, BIOTA-observatory at Luiperskop 211, S 31° 17' 37.1'', E 18° 36' 14.6'', 07.IX.2002, leg. M. Mennicken No. RSA 119, II III (PREM, M).
- On *Schismus barbatus*. South Africa, Western Cape Province, BIOTA-observatory at Luiperskop 211, S 31° 17' 13.7'', E 18° 36' 14.2'', 07.IX.2002, leg. M. Mennicken No. RSA 120, II III (PREM, M).
- On *Schismus barbatus*. South Africa, Western Cape Province, BIOTA-observatory at Moedverloren 208, S 31° 28' 00.7'', E 18° 26' 25.6'', 26.XI.2001, leg. M. Mennicken No. RSA 104, III (PREM, M).
- On *Tribolium echinatum* (Thunb.) Renvoize (= *Lasiochloa echinata* (Thunb.) Adamson), South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 31.0'', E 17° 32' 35.6'', 11.IX.2002, leg. M. Mennicken No. RSA 141, II III (PREM, M).
- On *Tribolium echinatum* . South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 29.4'', E 17° 33' 05.7'', 11.IX.2002, leg. M. Mennicken No. RSA 144, II III (PREM, M).

Our collections agree well with the range of spore dimensions given in the diagnoses of *Uromyces holci* and *Uromyces schismi*. Dimensions range from 23–29 x 20–24 µm for the urediniospores, and from 17–32 x 15–25 µm for the teliospores. The number of germ pores in the urediniospores of our collection is 7 to 11, noticeably higher than the number given in the diagnoses, where 6 or 7, respectively, scattered germ pores are mentioned. Cummins (1971) listed the number of germ pores as varying from 7 to 9. In his figure one urediniospore has 9 and one urediniospore has 11 germ pores. We hypothesise that *Uromyces holci* has 7 to 11 germ pores in its urediniospores.

As far as could be established, *Uromyces holci* is new to the rust flora of Namibia. *Karroochloa schismoides*, *Schismus barbatus* and *Tribolium echinatum* seem to be new host plants. *Uromyces holci* is the first known rust fungus that infects the grass genera *Karroochloa* and *Tribolium*. Whilst the host genus *Holcus* belongs to the subfamily Pooideae and the tribe Aveneae, the three host genera *Karroochloa*, *Schismus*, and *Tribolium* belong to the subfamily Arundinoideae and the tribe Arundineae (Fish 2000).

POACEAE - *Polypogon*

Puccinia polypogonis Speg. (Spegazzini 1909: 300). (Fig. 16)

Type on *Polypogon monspeliensis*, Argentina, near Lake Muster, Patagonia, XII.1902 (LPS, Isotype PUR).

Anamorph. *Uredo polypogonis* Speg. (Spegazzini 1899: 240). Lectotype on *Polypogon monspeliensis* (L.) Desf. Argentina, Puerto Deseado, 1885/1886.

Pycnia and aecia not known.

Uredinia amphigenous on leaves, mostly adaxial, and on sheaths, foxy red, subepidermal, forming partially confluent stripes between the nerves of the leaves, early exposed, pulverulent, surrounded by the torn epidermis. Urediniospores globoid to broadly ellipsoid, golden-brown, 22–29 x 19–27 µm, echinulate, spores borne singly on pedicels, spore wall uniformly about 1.5–3 µm thick, germ pores 6 to 8, with hyaline papillae that are largely developed.

Telia amphigenous on leaves, blackish-brown, subepidermal, (partly) developing from the uredinia, forming small, ellipsoid to oblong patches between the nerves of the leaves, early exposed, compact to cushion-like, surrounded by the torn epidermis. Teliospores in general bicellular, 31–51 x 15–25 (–27) µm, irregularly in shape and size, often oblique, varying from clavate to ellipsoid, occasionally diorchidioid, rounded, apiculate or flattened at the apex, attenuate or rounded at the base, constricted at the septum, brown, spore wall smooth, about 1.5–2.5 µm thick at the sides, about 2 to 9 µm thick at the apex, germ pores apical and just below the septum, pedicel persistent, up to 55 µm long, mostly collapsing, often obliquely inserted, brownish, just below the septum of the lower cell darker tinted. Mesospores commonly developed.

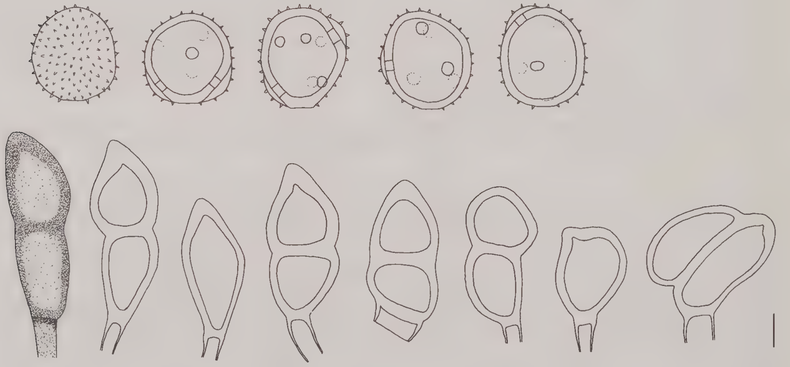

Fig. 16: *Puccinia polypogonis*. Uredinio- and teliospores on *Polypogon monspeliensis* (WIND 41741, WIND 63839). Scale bar = 10 µm.

Specimens examined:

- On *Polypogon monspeliensis*. Namibia, Lüderitz – Süd, Loreleifelsen- und Kupfermine und Umgebung, im Flussbett des Oranje, 2816 BB Oranjemund, 02.X.1977, leg. H. Merxmüller & W. Giess No. 32454, II (WIND 41741).
- On *Polypogon monspeliensis*. Namibia, Nuop Rivier, 3 km nördlich Einmündung in den Oranje, 2817 AA Vioolsdrif, 02.X.1975, leg. W. Giess No. 13837, (II) III (WIND 41744).
- On *Polypogon monspeliensis*. Namibia, Kaokoland Area 2, Skeleton Coast Park, Uniab River, 2013 AA, 50 m, 22.X.1988, leg. C. J. Ward & J. D Ward No. 10480, (II) III (WIND 63839).
- On *Polypogon monspeliensis*. South Africa, Northern Cape Province, BIOTA-observatory at Leliefontein 624, S 30° 23’ 39.5’’, E 18° 16’ 40.9’’, 27.XI.2001, leg. M. Mennicken No. RSA 60, II III (PREM, M).

- On *Polypogon monspeliensis*. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 23' 49.1'', E 18° 16' 45.2'', 27.XI.2001, leg. M. Mennicken No. RSA 68, II III (PREM, M).
- On *Polypogon monspeliensis*. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 23' 50.4'', E 18° 16' 45.8'', 27.XI.2001, leg. M. Mennicken No. RSA 70, II III (PREM, M).
- On *Polypogon monspeliensis*. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 23' 43.0'', E 18° 16' 43.7'', 27.XI.2001, leg. M.Göker No. RSA 74, II (PREM, M).
- On *Polypogon monspeliensis*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 18.4'', E 17° 33' 01.2'', 26.XI.2001, leg. M. Mennicken No. RSA 55, II (PREM, M). This collection is double infected with *Puccinia coronata* Corda (only teliospores).
- On *Polypogon monspeliensis*. South Africa, Western Cape Province, BIOTA-observatory at Elandsberg, S 33° 25' 55.4'', E 19° 02' 14.7'', 18.XI.2001, leg. M. Mennicken No. RSA 7, II (PREM, M).

As far as could be established, *Puccinia polypogonis* is new to the rust flora of Namibia. A South African collection from Saron in the Cape Province by Schlechter in 1890 (Jørstad 1956) is not cited in Crous, Phillips & Baxter (2000). The host plant *Polypogon monspeliensis* was introduced from Europe and Asia and is now naturalised in many parts of South Africa, especially in coastal areas (Bromilow 2001).

SANTALACEAE - *THESIUM*

Puccinia cf. ***stonemaniae*** Syd., P. Syd & Pole-Evans in Sydow & Sydow 1912: 437. (Fig. 17)

Type on *Thesium* sp. South Africa, Bain's Kloof near Wellington, 21.II.1912, leg. E. M. Doidge.

Anamorph. *Aecidium osyridicarpi* Massee 1911: 225. Type on *Osyridicarpos natalensis* DC. South Africa, Natal, Tabamhlope, leg. Wood No. 527.

Syn. *Puccinia pulvinata* Massee 1911: 224 (nec. Rabh.). Type on *Osyridicarpos natalensis*. South Africa, Natal, Tabamhlope, leg. Wood No. 527.

Syn. *Puccinia osyridicarpi* (Massee) Grove in Wakefield & Grove 1916: 76.

Pycnia not seen.

Aecia aecidioid, amphigenous on leaves and caulicolous, scattered in ± concentric groups up to 5 mm diameter, causing slight hypertrophy, without spots surrounding aecia, aecial cups small cylindrical, circa 250 µm diameter, up to 500 µm long, spore mass pale yellowish to white, surrounded by the irregularly and deeply frayed, orange-yellow to whitish peridium, cells of the peridium firmly connected, outer wall finely striate, circa 12–17 µm wide, inner wall delicately and closely verrucous, circa 4–6 µm wide. Aeciospores angular globoid, subgloboid to ovoid, 23–30 x 22–27 µm, spore wall about 1–1.5 µm thick, inconspicuously finely verrucous, hyaline, germ pores invisible.

Uredinia amphigenous on leaves and on stems, (partly) developing from the uredinia, subepidermal, roundish, ellipsoid or irregularly in outline, up to 1 mm wide, separate or scattered, without spots surrounding uredinia, cinnamon-brown, early exposed, pulverulent, surrounded by the torn epidermis. Urediniospores subgloboid, ovoid or ellipsoid, (26–) 29–37 x 22–30 µm, borne singly on pedicels, spore wall uniformly about 2–3 µm thick, yellowish-brown, noticeable verrucous, germ pores (3 to) 4 to 5, mostly ± equatorial, occasionally scattered, with hyaline papillae that are weakly developed.

Telia amphigenous on leaves and caulicolous, subepidermal, roundish, ellipsoid or irregularly in outline, up to 5 mm diameter, separate or scattered, blackish-brown to black, early exposed, compact to cushion-like, surrounded by the torn epidermis, without spots surrounding telia. Teliospores in general bicellular, obovoid, ellipsoid to oblong, slightly constricted at the septum, 38–48 x 21–31 µm, rounded or subacuminate at the apex, rounded or attenuate at the base, spore wall about 2–4 µm thick at the sides, about 6–9 µm thick at the apex, brown, smooth, germ pore of the upper cell apical, germ pore of the lower cell just below the septum, without papillae, pedicel persistent, up to 100 µm long, thick-walled, mostly not collapsing, yellowish to hyaline, sometimes obliquely inserted. Mesospores occasionally existing.

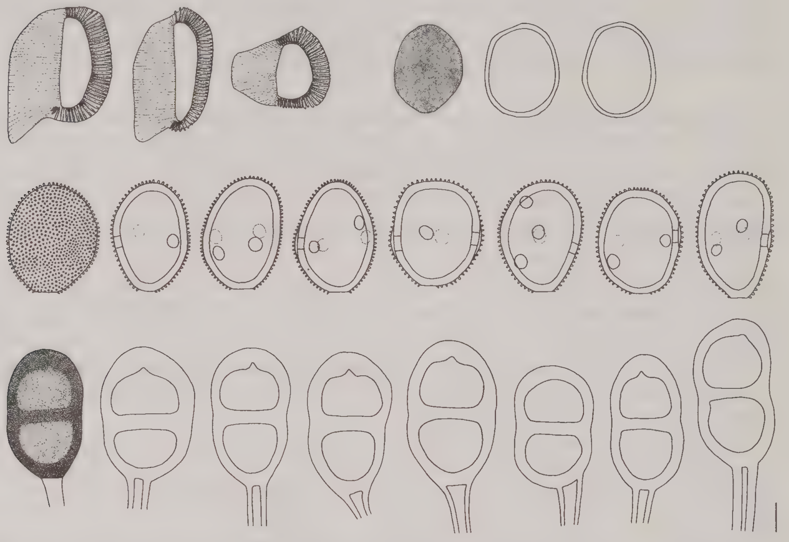

Fig. 17: *Puccinia* cf. *stonemaniae* on *Thesium* cf. *strictum*. Peridium cells and aeciospores (RSA 216), uredinio- and teliospores (RSA 3). Scale bar = 10 µm.

Specimens examined:

- On *Thesium* cf. *strictum* Bergius. South Africa, Western Cape Province, Cape Peninsula National Park, BIOTA-observatory at Olifantsbos, S 34° 15' 45.3'', E 18° 23' 36.6'', 17.XI.2001, leg. M. Mennicken No. RSA 3, II III (PREM, M).
- On *Thesium* cf. *strictum*. South Africa, Western Cape Province, Cape Peninsula National Park, BIOTA-observatory at Olifantsbos, S 34° 15' 41.1'', E 18° 23' 36.8'', 23.IX.2002, leg. M. Mennicken No. RSA 216, I (PREM, M).
- On *Thesium viridifolium* Levyns. South Africa, Western Cape Province, Cape Peninsula National Park, BIOTA-observatory at Olifantsbos, S 34° 15' 55.1'', E 18° 23' 52.5'', 23.IX.2002, leg. M. Mennicken No. RSA 217, II III (PREM, M).

Our collections do not agree very well with the description of *Puccinia stonemaniae* given in the diagnosis (Sydow & Sydow 1912) and in Doidge (1927). Therefore we use the epithet with the prefix cf. Unfortunately the type collection of *Puccinia stonemaniae* in Berlin got mouldy. Therefore, it could not be examined. *Thesium viridifolium* seems to be a new host plant.

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New species of *Asterina* from Guangdong, China

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Abstract—*Asterina daphniphyllicola* parasitic on *Daphniphyllum macropodum*, *Asterina dinghuensis* parasitic on *Cleistocalyx operculatus*, *Asterina euryae* parasitic on *Eurya acuminata*, and *Asterina myrsinacearum* parasitic on *Myrsinaceae* are described and illustrated as new species.

Key words—*Asterinaceae, Daphniphyllaceae, Myrtaceae, Theaceae*

Introduction

Guangdong Province of China is Mainland China's most southern region. It is close to Hainan Islands, and together they constitute the main tropical and subtropical region of the country. It is an area of abundant and diverse vegetation, characterized by warm, humid weather and frequent rainfall. It has one of the highest levels of fungal diversity of any area in China (Song et al. 2002, 2003). Recently, the first author had the opportunity to restudy the specimens of the asterinaceous fungi deposited in the Herbarium of Guangdong Institute of Microbiology (HMIGD), Guangzhou (China). The study shows that four taxa of the genus *Asterina* occurring in Guangdong are. They are apparently undescribed and are described and illustrated as new species as follows here.

Asterina daphniphyllicola B. Song, *sp. nov.* **Fig. 1**

> *Similis Asterina daphniphylli sed differt appressoriis et ascosporis brevioribus, appressoriis 10% oppostiis.*
>
> Etymology: *daphniphyllicola,* in reference to the host, *Daphniphyllum macropodum.*

Colonies amphigenous, mostly epiphyllous, black, thin, arachnoid to nearly velvety, scattered, up to 5 mm in diameter, sometime confluent. Hyphae brown, sinuous to nearly straight or mostly flexuous, irregularly branching acutely or widely, loosely or densely reticulate, cells mostly 18-30 x 4-5 μm. Appressoria unicellular, alternate to 10% opposite, spreading, straight or bent, ovate, obtuse or narrow at apex, entire to angular, sometime lobate, 7-10 x 5-7 μm. Ascomata scattered to nearly aggregate, black, orbicular to hemispherical, up to 230 μm in diameter, stellately dehiscent at the center, irregularly crenate to short tasseled at periphery, surface cells 2-3 μm wide. Ascospores cylindrical or fusoid, narrow or obtuse at ends, brown, 1-septate, constricted at septum, smooth, 25-33 x 8.5-10 μm.

> **Holotype:** *On leaves of Daphniphyllum macropodum Miq.(Daphniphyllaceae). Nankung Shan, Guangdong Provinice, China. September 17,1992, Y. S. Ouyang and B. Song, HMIGD 32067.*

The new species is closely related to *Asterina daphniphylli* W. Yamam. The main distinguishing characters of *A. daphniphylli* are that the appressoria are longer (9-18 μm), alternate and not opposite, and the ascospores are broader (12-16 μm) (Yamamoto 1956).

Asterina dinghuensis, *sp. nov.* **Fig. 2**

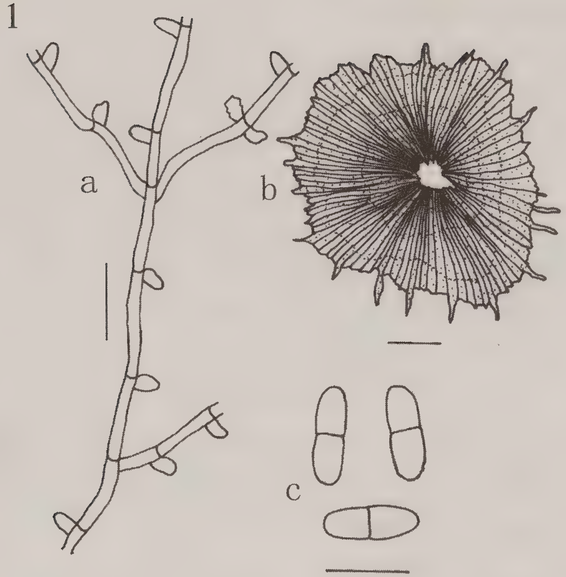
> *Similis Asterina assimilis sed differt appressoriis et ascosporis brevioribus; et a A. claviflori differt ascosporis grandioribus (20-28 x 10.5-12.5 μm).*
>
> Etymology: *dinghuensis,* in reference to the type locality, Dinghu Shan Biosphere Reserve.

Colonies amphigenous, thin, black, arachnoid or nearly velvety, up to 5 mm in diameter, sometimes confluent. Hyphae brown, sinuous or nearly straight, opposite or irregular branching acutely or obtusely, loosely to closely reticulate, cells mostly 20-45 x 3.8-5 μm. Appressoria unicellular, in alternate or unilateral arrangement, spreading, straight or slightly bent, cylindrical, narrow at apex, entire or sometimes angular, 10-16 x 4-5.5 μm. Ascomata scattered to nearly aggregate, black, orbicular or hemispherical, up to 260 μm in diameter, no apical pore or stellately dehiscent at center, irregularly crenate to shortly tasseled at periphery, surface cells 2-3.5 μm wide. Ascospores nearly ellipsoid to oblong, brown, 1-septate, obtuse, constricted at septum, smooth, 20-28 x 10.5-12.5 μm.

> **Holotype:** *On leaves of Cleistocalyx operculatus (Roxb.) Merr. et Perry (Myrtaceae). Dinghu Shan Biosphere Reserve, Guangdong Province, China. December 14, 1978, G.Z. Jiang, HMIGD 30008.*

The appressoria of this species are unicellular, alternate and not opposite, nearly cylindrical. This species is similar to *Asterina assimilis* Syd., *Asterina claviflori* A. K. Kar et Maity, *Asterina eugeniae* H. S. Yates, *Asterina natalitia* Doidge, and *Asterina rickii* Theiss. (Theissen 1913; Yates 1917; Sydow 1922; Doidge 1942; Kar & Maity 1970). According to their descriptions, the main distinguishing characters for *A. assimilis* are that the ascospores and the appressoria are broader (24-26 x 13-15 μm for the ascospores, 10-17 x 7-9 μm for the appressoria), and for *A. claviflori* that the ascospores are smaller (9.9-13.2 x 6.6-9.9 μm). The main distinguishing characters for *A. rickii* are that the ascospores are narrower (18-22 x 8-9 μm), and for *A. eugeniae* that the ascospores are smaller (20 x 5 μm) and the appressoria are irregular. In addition, the new species differs from *A. natalitia*, which has larger ascospores (30-34 x 12.5-15 μm). Therefore, they can clearly be distinguished from the new species.

The new species is found mixed with *Meliola leptospermi* Hansf. (Hu et al. 1996).



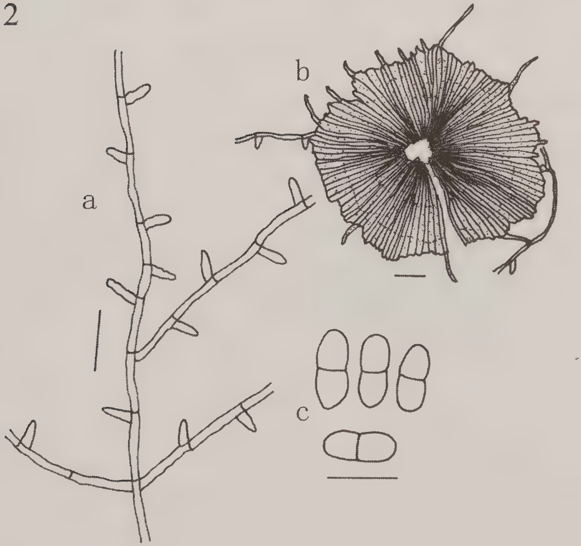


Fig.1 *Asterina daphniphyllicola* (a. hyphae with appressoria; b. ascoma; c. ascospores)

Fig.2 *Asterina dinghuensis* (a. hyphae with appressoria; b. ascoma; c. ascospores) (Bars = 25 μm).

Asterina euryae B. Song, *sp. nov.* **Fig. 3**

Similis Asterina theae sed differt ascosporis et appressoriis minoribus.
Etymology: *euryae*, in reference to the host, *Eurya acuminata.*

Colonies epiphyllous, thin, black, arachnoid to nearly velvety, up to 3 mm in diameter, sometimes confluent. Hyphae brown, nearly straight or curved, branching acutely or obtusely, loosely to closely reticulate, cells mostly 10-25 x 7-8 μm. Appressoria unicellular, in alternate or unilateral arrangement, spreading, straight or bent, globose, mostly angular or sublobate, 12-13 x 11-12.5 μm. Ascomata scattered to nearly aggregate, black, orbicular to hemispherical, up to 240 μm in diameter, stellately dehiscent at the centre, crenate to shortly tasseled at periphery, surface cells 2.5-3.5 μm wide. Ascospores oblong, brown, 1-septate, obtuse, constricted at septum, surface smooth, 30-33 x 11.5-12.5 μm.

Holotype: *On leaves of Eurya acuminata DC (Theaceae). Ruyang County, Guangdong Province, China. December 5, 1995, B. Song, HMIGD 34169.*

The new species is closely related to *Asterina theae* W. Yamam. The main distinguishing characters of *A. theae* are that the ascospores and the appressoria are larger (35-44 x 14-17 μm for the ascospores, 11-18 x 12-17 μm for the appressoria) (Yamamoto 1957).

Asterina myrsinacearum B. Song, *sp. nov* **Fig. 4**

Similis Asterina aphanes sed differt appressoriis grandioribus (10-19 x 8-12 μm) et ascosporis fusoideiis vel subellipsoideiis; et a A. embeliae differt ascosporis grandioribus (17-25 x 10-13 μm).
Etymology: *myrsinacearum*, in reference to the host, *Myrsinaceae indet.*

Colonies epiphyllous, black, thin to nearly dense, arachnoid to nearly velvety, up to 8 mm in diameter, sometimes confluent. Hyphae brown, nearly straight to slightly sinuous, opposite or irregular branching acutely or obtusely, loosely or closely reticulate, cells mostly 17-30 x 3.5-5 μm. Appressoria unicellular, in alternate or unilateral arrangement, less than 1 % opposite, spreading, mostly bent, nearly globose to oblong, 1-3-sublobate or sometimes angular, obtuse at apex, 10-19 x 8-12 μm. Ascomata nearly aggregate to scattered, black, orbicular or hemispherical, up to 130 μm in diameter, stellately dehiscent at the centre, crenate to shortly tasseled at periphery, surface cells 1.8-2.8 μm wide. Ascospores fusoid to nearly ellipsoid, brown, 1-septate, obtuse or narrowed at the ends, constricted at septum, surface smooth, 17-25 x 10-13 μm.

Holotype: *On leaves of Myrsinaceae indet. Yangchun County, Guangdong Province, China. September 1986, H. Hu, HMIGD 34437.*

The new species is closely related to *Asterina aphanes* Petr., *Asterina ardisiae* Hansf., and *Asterina embeliae* Hansf. (Sydow & Petrak 1929; Hansford 1943, 1954). The main distinguishing characters of *A. aphanes* are that the appressoria are smaller (6-8 x 7-8 μm), and the ascospores are oblong-clavate. The main distinguishing characters of *A. ardisiae* are that the appressoria are cylindrical (8-14 x 6-8 μm), attenuate at apex, and the ascospores are oblong. The new species differs from *A. embeliae* in the latter having larger ascospores (26-28 x 13-15 μm).

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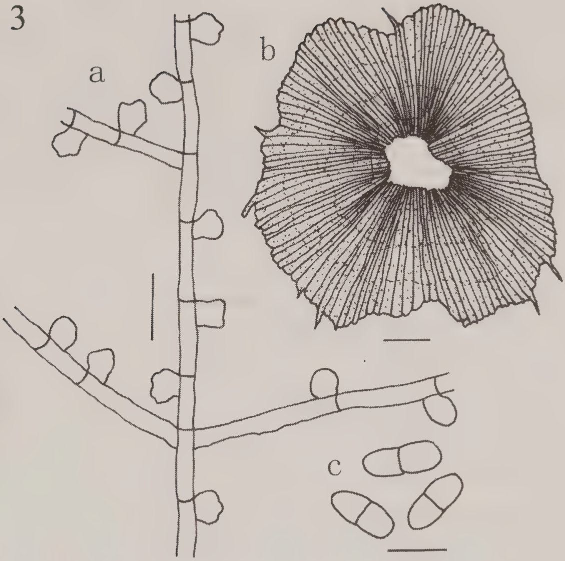

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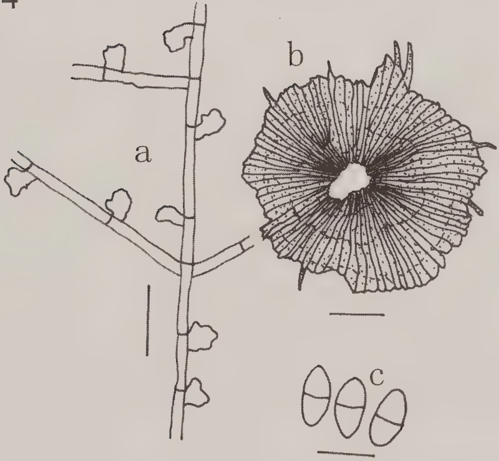

Fig.3 *Asterina euryae* (a. hyphae with appressoria; b. ascoma; c. ascospores) **Fig.4** *Asterina myrsinacearum* (a. hyphae with appressoria; b. ascoma; c. ascospores) (Bars = 25 μm).

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Preliminary survey of the *Helvellaceae* from Xinjiang, China

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Abstract -- Collections of the *Helvellaceae* from Xinjiang, China were examined. 17 taxa of the genera *Gyromitra*, *Helvella*, *Hydnotrya*, and *Wynnella* are recognized. Among them, *H. cupuliformis* var. *crassa* and *H. jimsarica* are new taxa. *Helvella cupuliformis* var. *cupuliformis* is new to China. Distinctions between the new taxa and their closely related species are discussed.

Key words -- taxonomy, *Gyromitra, Helvella, Hydnotrya, Wynnella*

Introduction

Xinjiang is in the northwest of China. It occupies more than 1/7 of the China mainland territory (Fig. 1). The area is covered with deserts, grasslands, conifer forests, broadleaf trees, and shrubs. The Tianshan Mountains run east-west in the area and separate it into two parts, North Xinjiang and South Xinjiang. Mt. Altay is located in the very north and Mt. Kunlun is at the southwest border. The Junggar Basin lies between Mt. Altay and the Tianshan Mountains. Tarim Basin lies between the Tianshan Mountains and Mt. Kunlun. The huge Taklimakan Desert is in the center of Tarim Basin. The mean annual precipitation varies from 50 mm to 600 mm. The mean annual temperature of flatlands is 6–8C in the north, 10–11C in the south; while that in the mountainous area is around 2.5–5C. Glaciers and snow cover the high peaks all the year round. Forests in Xinjiang mainly consist of *Picea, Larix, Abies, Pinus, Juniperus, Betula, Populus, Hippophae, Salix, Haloxylon, Tamarix, Calligonum, Nitraria,* etc. (Lu & Yan 1989).

A few helvellaceous cup-fungi were previously recorded from Xinjiang (Zhao & Mao 1986; Cao 1988; Cao et al. 1990a, b; Zhang 1990; Mao 1998).

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Recent collections of the Helvellaceae from Xinjiang were studied as were specimens of the group on deposit in the Mycology Herbarium, Chinese Academy of Sciences (HMAS). Thirteen taxa of *Helvella*, 2 of *Gyromitra*, 1 of *Hydnotrya*, and 1 of *Wynnella* are recognized. Xinjiang is rich in *Helvella* taxa and has high species diversity accounting for 40% of the total known species in China (Zhuang 1998). *Helvella costifera*, *H. crispa*, *H. cupuliformis* var. *cupuliformis*, *H. ephippium*, and *H. macropus* are the common species there. *Helvella cupuliformis* var. *cupuliformis* is a new record for China. *Helvella cupuliformis* var. *crassa* and *H. jimsarica* are described as new taxa. *Gyromitra* is also frequently encountered there. Collections of the genus from the eastern Xinjiang are mostly *G. infula*, while those from the west belong to *G. xinjiangensis*. *Hydnotrya* seems not to be widely dispersed. *Wynnella* is possibly common in Xinjiang.

Taxonomy

Gyromitra infula (Schaeff.) Quél., Ench. Fung. p. 272, 1886.

Specimens examined: CHINA. Xinjiang, Tuomuerfeng, VIII 1978, on rotten wood, S.X. Sun, H.A. Wen & X.L. Mao 597, HMAS 39333; Tianchi, alt. 1900 m, 31 VII 2003, on rotten wood, mycological team WYZ 4603, 4604, HMAS 86061, 86060; Jimsar, alt. 1700 m, 1 VIII 2003, on rotten wood, W.Y. Zhuang & Y. Nong 4659, HMAS 86057; Burqin, Hemuxiang, alt. 1100 m, 5 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4692, 4693, HMAS 86059, 86058; Burqin, Hemuxiang, alt. 1100 m, 6 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4731, 4732, HMAS 86056, 86055; Altayshan, alt. 1250 m, 9 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4820, HMAS 86054; Altayshan, alt. 1250 m, 9 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4829, HMAS 86049.

Gyromitra xinjiangensis J.Z. Cao, L. Fan & B. Liu, Acta Mycol. Sin. 9: 105, 1990.

Specimens examined: CHINA. Xinjiang, Hejing, 1 VIII 1958, on rotten wood, L.W. Xu 132, HMAS 27863; Tuomuerfeng, 11 VII 1978, on the ground, S.X. Sun, H.A. Wen & X.L. Mao 760, HMAS 39091; Tuomuerfeng, 11 VII 1978, on rotten wood, S.X. Sun, H.A. Wen & X.L. Mao 598, HMAS 39334; Xinjiang, VIII 1994, on rotten wood, J.Y. Wang 310, HMAS 71869; Yining, Qapqal, alt. 2000 m, 13 VIII 2003, on rotten wood, W.Y. Zhuang & Y. Nong 4894, 4905, HMAS 86048, 86047; Xinyuan, Nalati, alt. 2200 m, 15 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4964, 4968, HMAS 86046, 86053; Xinyuan, Gongnaisi, alt. 2170 m, 16 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4981, HMAS 86052.

Notes: This species is very similar to *Gyromitra infula* in gross morphology but different from the latter in the ascospore surface morphology, spore guttulation, and fruitbodies with a relatively short stipes (Cao et al. 1990a).

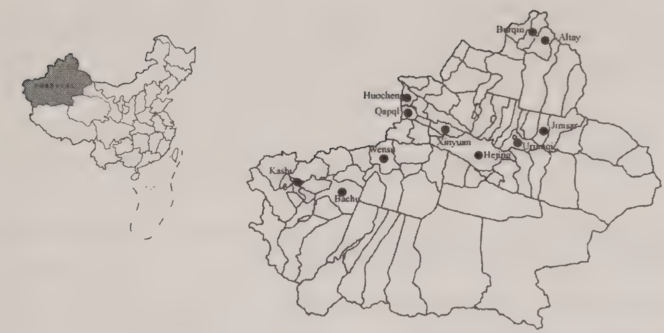
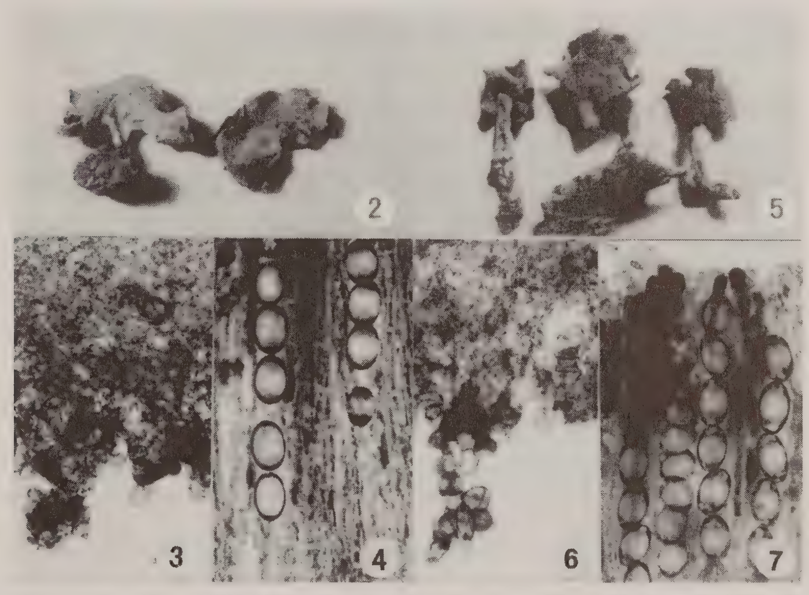

Burqin
Altay
Huocheng
Qapql
Jimsar
Xinyuan
Urumqi
Wensu
Heping
Kashi
Bachu

Fig. 1 Map of China showing location of Xinjiang (left), map of Xinjiang showing collecting sites of the helvellaceous fungi (right).



Figs. 2-7 Morphology of *Helvella* spp. Figs. 2-4 *Helvella cupuliformis* var. *crassa* (paratype): 2. Dried fruitbodies, x0.75; 3. Ectal excipular structure, x165; 4. Ascospores, x330. Figs. 5-7 *Helvella jimsarica* (holotype): 5. Dried fruitbodies, x0.4; 6. Ectal excipular structure, x165; 7. Ascospores, x330.

Helvella acetabulum (L.) Quél., Ench. Fung. p. 275, 1886.

Specimens examined: CHINA. Xinjiang, Tuomuerfeng, 27 VI 1977, on the ground, H.A. Wen & X.L. Mao 53, HMAS 38329; Tuomuerfeng, 29 VI 1977, on the ground, H.A. Wen & X.L. Mao 56, HMAS 38129; Tianchi, alt. 1900 m, 31 VII 2003, on the ground, mycological team WYZ 4614, HMAS 86051; Jimsar, alt. 1700 m, 1 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4649, HMAS 86050.

Helvella atra Holmskj. : Fr., Beata Ruris Otia Fungis Danicis Impensa 2: 47, 1799.

Specimens examined: CHINA. Xinjiang, Burqin, Hemuxiang, alt. 1100 m, 5 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4695, 4727, HMAS 86045, 86044.

Helvella costifera Nannf., in Lundell & Nannfeldt, Fungi Exsic. Suec. Praes. Upsal. Fasc. 41-42: 37, no. 2061, 1953.

Specimens examined: CHINA. Xinjiang, Tianchi, alt. 1900 m, 31 VII 2003, on the ground, mycological team WYZ 4600, 4616, HMAS 86043, 86042; Jimsar, alt. 1700 m, 1 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4638, 4661, HMAS 86041, 86040; Jimsar, alt. 1700 m, 2 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4662, 4667, 4669, 4679, HMAS 83506, 83507, 83508, 83509; Hemuxiang, alt. 1100 m, 5 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4684, HMAS 83510; Guozigou, alt. 1800 m, 11 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4864, 4865, HMAS 83511, 83512.

Helvella crispa (Scop.) Fr., Syst. Mycol. 2: 14, 1822.

Specimens examined: CHINA. Xinjiang, Jimsar, alt. 1700 m, 2 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4666, HMAS 83513; Burqin, Hemuxiang, alt. 1100 m, 5 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4697, 4696, HMAS 83514, 83550; Altayshan, alt. 1250 m, 9 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4821, 4822, HMAS 83515, 83516; Guozigou, alt. 1800 m, 11 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4867, HMAS 83517; Yining, Qapqal, alt. 2000 m, 13 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4898, HMAS 83518.

Helvella cupuliformis Dissing & Nannf., Sv. Bot. Tidskr. 60: 326, 1966. var. **cupuliformis**

Specimens examined: CHINA. Xinjiang, 15 VII 1978, on the ground, S.X. Sun, H.A. Wen & X.L. Mao 421, HMAS 38330; 23 VII 1977, on the ground, H.A. Wen & X.L. Mao 137, HMAS 38331, Tianchi, alt. 1900 m, 31 VII 2003, on the ground, mycological team WYZ 4605, 4606, 4618, HMAS 83519, 83520, 83521; Jimsar, alt. 1700 m, 1 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4646, HMAS 83522.

Helvella cupuliformis var. **crassa** W.Y. Zhuang, var. nov. Figs. 2–4

Ab *Helvella cupuliformis* var. *cupuliformis* ascosporis crassis, 18–21 x 12.5–15 μm differt.

Pileus discoid, 1.5–5.5 cm in diam., hymenium surface grayish brown to grayish, receptacle surface pubescent, pale gray, stipe terete, short, nearly smooth, beige; ectal excipulum of textura angularis, 115–130 μm thick excluding pustules, outermost cells thin-walled, hyaline, club-shaped, 18–31 x 7.5–20 μm; medullary excipulum of textura intricata, hyphae hyaline, 2.5–5 μm wide; subhymenium not clearly defined; hymenium 230–245 μm thick; asci subcylindrical, 8-spored, J– in Melzer's reagent, 18–20 μm wide; ascospores broadly ellipsoid, uniguttulate, 18–21 x 12.5–15 μm; paraphyses somewhat enlarged at apex, 4.5–6 μm wide at apex.

Holotype: CHINA. Xinjiang, Tianchi, alt. 1900 m, 31 VII 2003, on the ground, mycological team WYZ 4615, HMAS 83523. Paratype: Xinjiang, Jimsar, alt. 1700 m, 1 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4648, HMAS 83524.

Notes: The new variety is very similar to *Helvella cupuliformis* var. *cupuliformis* in gross morphology and anatomic structure but differs significantly in the large fruitbodies and much wider ascospores (18–21 x 12.5–15 μm *vs*. 18–20 x 11.5–13 μm) (Dissing 1966).

Helvella elastica Bull., Herb. France Pl. 242, Figs. A, B, D-E, 1785.

= *Helvella xinjiangensis* J.Z. Cao, L. Fan & B. Liu, Acta Mycol. Sin. 9: 186, 1990.

Specimens examined: CHINA. Xinjiang, Tuomuerfeng, 27 VII 1978, X.L. Mao *et al*. 447, HMAS 38353 (holotype of *H. xinjiangensis*); Jimsar, alt. 1700 m, 1 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4641, HMAS 83525; Mt. Altay, alt. 1250 m, 9 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4835, HMAS 83526.

Notes: Significant distinctions were not found between the holotype of *Helvella xinjiangensis* and *H. elastica* (Dissing, 1966, Cao *et al*., 1990b).

Helvella ephippium Lév., Ann. Sci. Nat. Ser. 2, 16: 240, 1841.

Specimens examined: CHINA. Xinjiang, Hejing, 2 VIII 1958, on the ground in woods, L.W. Xu 153, HMAS 27866; Tuomuerfeng, 15 VII 1978, on the ground in woods, X.L. Mao *et al*. 423, HMAS 38354; Tianchi, alt. 1900 m, 31 VII 2003, on soil, fungus collecting team, WYZ 4601, HMAS 83527; Jimsar, alt. 1700 m, 1 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4639, HMAS 83528; Guozigou, alt. 1800 m, 11 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4870, HMAS 83529; Yining, Qapqal, alt. 2000 m, 13 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4923, HMAS 83530.

Helvella jimsarica W.Y. Zhuang, sp. nov. Figs. 5-7

Ab *Helvella elastica* apotheciis lignicola, grandiebus, superficiebus receptaculo pustulatis, pubescens vel villosis, subhymeniis tennuibus differt.

Pileus discoid to somewhat saddle-shaped, up to 5.5 cm in diam. and 8 cm high when fresh, hymenium surface beige to brown when fresh and dark brown when dry, receptacle surface pubescent to villose, often with minute pits observed when dry, light grayish brown to grayish brown when fresh and grayish cinnamon when dry, stipe terete, with a pubescent to villose surface, beige when fresh and straw-colored to grayish beige when dry; ectal excipulum of textura angularis, 75–100 μm thick excluding the pustules, pustules 25–80 μm high, outermost cells thin-walled, club-shaped, (12–)15–38 x 7.5–21 μm, arranged in chains to give rise to the pustules; medullary excipulum of textura intricata, 330–600 μm thick or thicker, hyphae hyaline, 3–7.5 μm wide; subhymenium *ca* 50 μm thick; hymenium 250–280 μm thick; asci subcylindrical, 8-spored, J– in Melzer's reagent, 13–16.5 μm wide; ascospores ellipsoid to broadly ellipsoid, some with warts on surface, uniguttulate, uniseriate, 16.5–21 x 10–13 μm; paraphyses enlarged to 6–7 μm wide at apex.

Holotype: CHINA. Xinjiang, Jimsar, alt. 1700 m, 1 VIII 2003, on rotten wood, W.Y. Zhuang & Y. Nong 4660, HMAS 83531. Paratype: CHINA. Xinjiang, Jimsar, alt. 1700 m, 1 VIII 2003, on plant debris, W.Y. Zhuang & Y. Nong 4640, HMAS 83532.

Notes: The hymenium surface color of *Helvella jimsarica* when fresh resembles that of *Helvella elastica*, but the surfaces of receptacle and of stipe are entirely different from those in *H. elastica*. The new species is characterized by the very large fruitbodies up to 5.5 cm in diameter and 8 cm high, pubescent to villose receptacle surface light grayish brown to grayish brown, with minute pits on surface when dry, as well as its occurrence on rotten wood and plant debris.

Helvella lacunosa Afz. : Fr., Kgl. Vet.-Akad. Nya Handl. 4, p. 303, 1783.
= *Helvella sulcata* Afz. Kgl. Vet.-Akad. Nya Handl. 4, p. 305, 1783.

Specimens examined: CHINA. Xinjiang, Tuomuerfeng, on the ground in woods, 24 VII 1977, X.L. Mao 158, HMAS 38355; Jimsar, alt. 1700 m, 1 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4628, 4642, HMAS 83533, 83537; Jimsar, alt. 1700 m, 2 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4663, 4678, HMAS 83534, 83535; Burqin, Hemuxiang, alt. 1100 m, 5 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4694, HMAS 83536.

Notes: HMAS 83537 is somewhat different from other collections. The gross morphology of the fungus is very similar to that of typical *Helvella lacunosa*. It is distinguished from Nordic (a), British (b), and other Chinese (c) collections in wider asci [15–20 μm *vs.* 13–16 μm (a), *ca* 18 μm (b), and 15–18 μm (c) wide], larger ascospores [18–21.5 x 11.5–14.5 μm *vs.* 15–17.1 x 9.5–12 μm (a), 17–20 x 11–13 μm (b), and 15–20 x 11.5–13 μm (c)], and lack of a well-developed subhymenium (Dissing 1966, Dennis 1978). Since spore sizes of specimens from the different geographical areas do not differ clearly, the above distinctions are treated as variations currently unworthy of taxonomic rank. The morphology of HMAS 83537 is described as follows.

Pileus saddle-shaped, 2–5 μm wide and 4.5–9 μm high, hymenium surface grayish brown, receptacle surface paler and smooth to slightly pubescent, stipe robust, with longitudinal furrows, pale grayish to nearly black when dry; ectal excipulum of textura angularis, 130–155 μm thick, cells thin-walled, forming a palisade outer layer, 20–38 x 13–20 μm; medullary excipulum of textura intricata, 280–380 µm thick or thicker, hyphae hyaline, 2–5 µm wide; subhymenium not clearly recognized; hymenium 305–325 µm thick; asci subcylindrical, (4–)8-spored, J– in Melzer's reagent, 15–20 µm wide; ascospores broadly ellipsoid, uniguttulate, uniseriate, 18–21.5 x 11.5–14.5 µm; paraphyses enlarged at apex, 5–7.5(–8) µm wide near apex and 3–3.5(–4) µm wide below.

Helvella macropus (Pers. : Fr.) P. Karst., Not. Sällsk. F. Fl. Fenn. Förh. 11: 224, 1870.

Specimens examined: CHINA. Xinjiang, Tianchi, alt. 1900 m, 31 VII 2003, on the ground, mycological team WYZ 4617, HMAS 83538; Jimsar, 1700 m, 1 VIII 2003, on duff, W.Y. Zhuang & Y. Nong 4626, HMAS 83539; Jimsar, 1700 m, 2 VIII 2003, on duff, W.Y. Zhuang & Y. Nong 4674, HMAS 83540; Burqin, Hemuxiang, alt. 1100 m, 5 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4698, HMAS 83541; Guozigou, alt. 1800 m, 11 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4851, 4868, 4869, HMAS 83542, 83543, 83544.

Helvella phlebophora Pat. & Doass., in Pat., Tab. Anal. Fung. 5: 208, 1886.

Specimen examined: CHINA. Xinjiang, Burqin, Hemuxiang, alt. 1100 m, 6 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4774 , HMAS 83545.

Helvella spadicea Schaeff., Fung. Icon. 3, Tab. 283, 1772; l.c. 4: 112, 1774.
= *Helvella leucopus* Pers., Mycol. Eur. 1: 213, 1822.

Specimens examined: Bachu, VI 1985, on the ground, C. Gao 1661, HMAS 50932; Bachu, V 1986, Anon. 1904, HMAS 53650; V 1987, on the ground I broadleaf forest, Z.Y. Zhao, HMAS 57640; Kashi, on the ground in broadleaf forest, Q. Ji, HMAS 72884.

Notes: The fungus was previously recorded in the Chinese literature as *Helvella leucopus* (Mao 1998).

Hydnotrya cerebriformis Harkn., Proc. Calif. Acad. Sci. 3, 1: 266, 1899.
Specimen examined: CHINA. Xinjiang, Xinyuan, Nalati, alt. 2200 m, 15 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4954, HMAS 83546.

Notes: According to Zhang (1990), the fungus was also collected in Qitai County in the east of Xinjiang.

Wynnella auricula (Schaeff.) Boud., Hist. Class. Discom. Eu. p. 51, 1907.
≡ *Elvela auricula* Schaeff., Fung. Bavar. Ind. p. 103, 1774.
= *Wynnella atrofusca* (Beck) Svrcek, Ceska Mykol. 17: 45, 1963.
≡ *Otidea atrofusca* Beck, flora Herstein S. A. p. 131, 1885.
= *Wynnella silvicola* (Beck in Sacc.) Nannf., Ann. Bot. Fenn. 3: 309, 1966.
≡ *Otidea silvicola* Beck in Sacc., Syll. Fung. 8: 97, 1889.

Specimens examined: CHINA. Xinjiang, Jimsar, alt. 1700 m, 1 VIII 2003, on rotten wood, A. Abbas, W.Y. Zhuang & Y. Nong 4668, HMAS 86062; Yining, Qapqal, alt 2000, 13 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4924, HMAS 83547; Guozigou, alt. 1800 m, 11 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4866, HMAS 83548.

Notes: The fungus has been found in North America, Europe, and China (Seaver 1928, Dissing 1966, Eckblad 1968, Hansen & Knudsen 2000). It obviously has north temperate distribution. It was previously collected from Mt. Guancen in Shanxi Province, Urmuqi in Xinjiang, and Mt. Yulong in Yunnan (Cao 1988).

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Genetic variability in tropical and temperate populations of *Trapeliopsis glaucolepidea:* Evidence against long-range dispersal in a lichen with disjunct distribution

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Abstract—The squamulose lichen *Trapeliopsis glaucolepidea* displays a widely disjunct distribution in Europe, East Africa, tropical America, and New Guinea. Using ITS sequences from 38 European and 31 Latin American individuals, we compared the genetic variability within and among populations of this species. Specifically, we addressed the questions whether recurrent genetic exchange occurs between Latin America and Europe, whether there are signs of historical long-range dispersal, whether genetic variability is higher in tropical than in temperate populations, and whether the separation of *T. glaucolepidea* and *T. percrenata* is supported by genetic characters. Intercontinental gene flow seems to be absent and there are also no signs of historical long-range dispersal. Two deviating haplotypes from Europe might belong to an unrecognized species or indicate the presence of paralogous ITS sequences. But our dataset does not support separation of *T. glaucolepidea* and *T. percrenata* based on morphological characters. More thorough sampling efforts and more sequences are necessary to make more detailed inferences on the phylogeography of *T. glaucolepidea.*

Key words—genetic diversity, lichenized fungi, nuclear DNA, Ecuador, Czech Republic

Introduction

Phylogeography provides powerful tools for the study of historical biogeography, dispersal biology, and speciation in various organismal groups (e.g. Avise 2000, Templeton 1998, 2001). Since direct observations are impossible inferences about a species' history can only be made based on genetic data. Population genetics of lichens is still largely unexplored and thus most questions concerning the dispersal, biogeography or speciation of lichens are still unanswered (Printzen & Ekman 2002). Especially the wide disjunctions of many lichen species as compared to other organisms, such as phanerogams are still unexplained. Fragmentation of formerly coherent distributional ranges and long-range dispersal were both invoked as explanations. Some of the first published studies on infraspecific genetic variability of lichens concentrated on biogeographical questions, but came to deviating conclusions. Printzen et al. (2003)

inferred that the North American-European disjunction of *Cavernularia hultenii* was due to the postglacial fragmentation of a circumarctic distributional area, while Högberg et al. (2002) concluded that European populations of *Letharia vulpina* were the result of long range dispersal from North America. In this study we try to provide data on the genetic variability of another lichen species, this time with a peculiar tropical-European disjunction.

Trapeliopsis glaucolepidea (Nyl.) G.Schneider (*Ascomycotina*, *Agyriales*) is a widespread squamulose lichen. Outside Europe, it is reported from higher elevations (mostly above 3000 m) in the tropics: East Africa (Swinscow & Krog 1988), Central & Southern America (Sipman 1999) and Papua New Guinea (Aptroot & Sipman 1991). A few additional unpublished collections exist from montane areas in Asia and a middle-montane region in South America (Palice, unpubl.). No North American records are known so far. In Colombia (Cleef in sched., cf. Sipman et al. 2000) and Ecuador (Palice, pers. obs.) *T. glaucolepidea* appears to be one of the most prominent cryptogamic components of the wet high-páramo – a mountain ecosystem characteristic for the Northern Andes. It grows mainly on naked peat, soil, dry grass tussocks, decaying rosettes of *Asteraceae*, *Apiaceae* and other kinds of plant debris. More rarely, it may be found on rocks or bark covered by mosses or decaying wood. In Europe, the species is best developed in the British Isles, where it preferably occupies open moorland areas at higher elevations. In continental Europe, *T. glaucolepidea* prefers boreal coniferous forests, but also occurs in humid mixed/deciduous forests. Within one locality the species may grow on different substrates: soil, wood, shaded rock and plant debris. The most favoured substrate is relatively freshly exposed, naked peat, e.g. among roots of upended trees. It may also grow epiphytic at the bases of trees (Hafellner 2002).

T. glaucolepidea is a morphologically variable species. Andean and European populations differ in thallus size and in the production of apothecia. In general, the tropical specimens are larger (forms with small squamules are very rare) and more frequently fertile. Well developed tropical individuals can form large palmate squamules exceeding 1 cm in diameter. The best developed specimens from W-European moorlands are morphologically rather similar to average individuals from the tropics forming characteristic grey squamules c. 1-4 mm broad with bluish-grey labriform marginal soralia. Wood-inhabiting European specimens, on the other hand, may have squamules of the breadth only 0.3-1.0 mm. As they may produce soralia at a very early stage it can be difficult to distinguish squamules at all. In Central Europe, a continuum of intermediate forms between the extremes occurs. Thalli of smaller shade forms often lack the bluish tinge and the soralia are pale green to creamy white. Richly fertile specimens are only sparsely sorediate or the soredia are missing completely. The tropical material and the upland specimens from the British Isles have comparatively large apothecia, often above 1 mm in diameter while the specimens from forests produce the apothecia more rarely and they are usually smaller, rarely exceeding 1 mm in diameter. The above mentioned morphological differences apparently reflect environmental conditions, such as light, humidity, character of substrate (texture, decay rate, disturbance of surface) and perhaps also intra- and interspecific competition with other organisms.

Small specimens from decaying wood in West/Central European woodlands are usually called *Trapeliopsis percrenata*. Based on statements on Scandinavian material (cf. Muhr 1986), observations from Bohemia and the respective herbarium material, Palice (1999) concluded that *T. percrenata* is conspecific with *T. glaucolepidea*. In the South American páramo, sorediate specimens and richly fertile individuals without soralia occur. Their status is often difficult to assess. In addition to sparsely sorediate forms of *T. glaucolepidea*, non-sorediate specimens with potential affinities to the African *T. haumanii* or the Australasian *T. colensoi* (indicated by ITS data not included in the current study) might be present.

This study attempts a preliminary answer on three main questions. (1) Is there evidence for recurrent or historical genetic exchange between Latin American and European populations of *T. glaucolepidea*? (2) Are there differences in the genetic diversity of tropical vs. temperate populations. (3) Is there evidence that morphologically different specimens (previously referred to *T. glaucolepidea* and *T. percrenata*) really belong to two different species. Particularly with regard to this last question, but also in order to capture as much of the genetic diversity of *T. glaucolepidea* as possible, our sampling tries to cover the complete morphological variability of European and Latin American *T. glaucolepidea*.

Materials and Methods

Sampling

We sampled 38 European and 31 Latin American individuals of *T. glaucolepidea* (Append. 1) trying to cover the morphological variation of this species. For the comparison of genetic variability in tropical and temperate populations, we sampled several specimens from nearby populations in approximately equal areas of Ecuador (as a hypothetical diversity center) and the Czech Republic. In Ecuador, we chose four closely situated populations at Volcán Chíles, prov. Carchi (E1, n=17), a population in the NP Llanganates, prov. Napo/Tungurahua (E2, n=7), and one in the NP Podocarpus, Loja prov. (E3, n=4) for more intensive sampling. In the Czech Republic two populations in the NP Šumava, S-Bohemia (C1, n=12) and the NP České Švýcarsko, N-Bohemia (C3, n=7) were selected (Tab. 3, cf. Append. 1). The size of the populations varies somewhat within our dataset but was chosen so that the most distant collections from one population are not situated more than 50 km from each other. Only specimens that were clearly assignable to *T. glaucolepidea* were sampled, ITS sequences of non-sorediate specimens were only included when they belonged to one of the "sorediate" haplotypes.

DNA-sequencing

DNA was extracted from the vegetative lichen thalli using the NucleoSpin® Plant Kit (Macherey Nagel) according to the manufacturer's protocol. In order to minimize contamination by other fungi – when feasible – younger thalli were used, and cortex and soralia were cut-off. PCR amplification of the internal transcribed spacer of the nuclear ribosomal DNA repeat (ITS) was performed in 50 μL volumes containing 3-4 μL DNA, 5 μL 10 x reaction buffer, 2.5 mM $MgCl_2$, 1 mM dNTPs, 1 U *Taq* (MBI Fermentas), and 0.8 μM each of the primers ITS 1 F-5´ (Gardes & Bruns 1993) and ITS 4-3´ (White et al. 1990). Cycling conditions were as follows: initial denaturation at 94°C (4'), 6 cycles of a touch-down PCR with 94°C (1'), 62°C (-1°C per cycle) (1'), 72°C

(1'45"), 34 cycles with 94°C (30"), 56°C (30"), 72°C (1'45"), and a final extension of 72°C (10'). PCR products were purified with the QIAquick™ PCR purification kit (QIAGEN). Purified PCR-products were sequenced by GATC Biotech AG (Konstanz, Germany). Both strands were sequenced for new haplotypes. In all other cases (except when sequence chromatograms were of poor quality) only one strand was sequenced. One sequence of every observed haplotype was deposited in GenBank (access. numbers AY600064-AY600082).

Data Analysis

An alignment of 69 ITS sequences was calculated with the program ClustalW as implemented in the software BioEdit (Hall 1999) and manually adjusted. In order to display the phylogenetic relationships within the dataset, a haplotype network was calculated under the 95% parsimony probability criterion (Templeton et al. 1992) using the software TCS version 1.06 (Clement et al. 2000) with gaps treated as a 5th character state. Root probabilities (outgroup weights) were calculated for each haplotype according to the heuristic algorithm introduced by Castelloe & Templeton (1994) and according to the modified algorithm by Cassens et al. (2003). Parameters of genetic diversity were calculated using DNASP version 3.99 (Rozas & Rozas 1999). Parameters were calculated for the two European and three Ecuadorian populations from which four or more individuals were sampled (Tab. 2). In addition, genetic diversity within Europe and Latin America respectively was estimated on the basis of all sampled specimens. As estimators of genetic diversity, we calculated haplotype diversity h (Nei 1987) and nucleotide diversity Pi (π). All calculations were performed on two different datasets: one containing all sampled haplotypes and one excluding the deviating European haplotypes H1 and H2 (see below). DNASP ignores positions with gaps, and consequently pools haplotypes that only differ by indels. In order to calculate correct haplotype diversity indices, we recoded positions 12, 13, 18 and 140 of our alignment. Haplotype diversity indices of populations were compared using a two-tailed t-test as described in Zar (1999; equations 8.62 and 8.65) and significance values obtained by an internet application (URL: http://home.clara.net/sisa/signif.htm). The calculation of nucleotide diversity was performed on the original alignments without recoding. Because of multiple hits at positions 69, 90, 113 and 353 of the alignment we used the Jukes and Cantor correction (Jukes & Cantor 1969) to calculate Pi (π). We used an analysis of molecular variance (AMOVA, Excoffier et al. 1992) to partition the total genetic variance of our sample into components due to differences within populations, among populations within continents (Europe and Latin America), and among continents using Arlequin version 2.001 (Schneider et al. 2001). For this analysis we used the same five populations as for the calculation of genetic diversity. Again, calculations were performed on the two datasets outlined above.

Results

The complete aligned dataset is 530 bp long and contains 48 polymorphic sites. Nineteen haplotypes can be distinguished (Tab. 1). The cladogram in Fig. 1 consists of two clades that are not connected to each other under the 95% parsimony probability criterion. The two haplotypes H1 and H2 are separated from the rest of the network by at least 21 mutational steps. This distance is almost as large as the minimum distance

Table 1: ITS haplotypes of *Trapeliopsis glaucolepidea* and their frequencies in different geographical areas. Only polymorphic sites are listed, with their respective base numbers in the alignment. Sites with multiple hits are in bold face. Sites that were recoded for the calculation of haplotype diversity are denoted by asterisks.

	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	**1**	1	1	1	1	1	1	1	1	1	1	3	3	3	**3**	3	3	3	3	3	3	4	4	4	4	4	4		
	0	0	1	1	1	1	3	4	4	4	5	5	**6**	7	7	7	8	8	8	**9**	9	**1**	2	3	3	4	4	6	6	7	7	8	0	2	5	**5**	6	7	7	8	8	9	0	3	4	6	8	8		
Haplotype	1	7	2	3	4	8	6	3	7	9	2	4	**9**	0	1	5	4	6	7	**0**	8	**3**	3	0	1	0	6	2	9	2	6	3	8	6	1	**3**	9	5	6	2	3	4	2	6	7	0	0	1	**Latin America**	**Europe**
			*	*		*																				*																								
H 03	C	G	T	C	C	-	T	T	C	T	C	T	**T**	C	C	C	C	T	-	**T**	C	**T**	A	C	T	-	A	A	G	-	T	-	T	C	C	**G**	T	C	C	C	G	G	A	T	G	T	T	C	0	1
H 04	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	.	.	0	7
H 05	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**G**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	G	.	.	.	.	.	0	5
H 06	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**G**	.	.	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	G	.	.	.	.	.	0	1
H 07	.	.	.	.	.	C	.	.	.	.	T	.	**C**	.	.	.	.	.	.	**A**	.	.	.	.	.	.	G	.	T	.	.	.	.	T	.	**C**	.	.	.	.	.	.	G	C	.	.	-	-	0	13
H 08	.	.	.	.	.	.	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	T	.	.	.	.	T	T	**C**	.	T	T	.	.	.	G	C	.	.	-	.	1	0
H 09	.	.	.	.	.	.	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	T	.	.	.	.	T	.	**C**	.	.	.	T	.	.	G	C	.	.	-	-	1	0
H 10	.	.	.	.	.	.	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	T	.	**C**	.	.	.	.	.	.	G	C	A	.	-	-	3	0
H 11	.	.	.	.	.	.	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	T	.	**C**	.	.	.	.	.	.	G	C	.	.	-	-	7	0
H 12	.	.	.	.	.	.	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	C	.	.	T	.	**C**	C	.	.	.	.	A	G	C	.	.	-	-	1	0
H 13	.	.	.	.	.	.	.	.	.	.	T	.	**C**	.	.	.	.	.	.	**C**	T	.	.	.	.	.	.	.	T	.	C	.	.	T	.	**C**	C	.	.	.	.	.	G	C	.	.	-	-	1	0
H 14	.	.	.	.	.	.	.	C	.	.	T	.	**C**	.	.	.	.	.	.	**C**	.	.	.	.	.	.	.	.	T	.	C	.	.	T	.	**C**	C	.	.	.	.	.	G	C	.	.	-	-	1	0
H 15	.	.	.	.	.	.	.	.	.	.	T	.	**C**	.	.	.	.	.	.	**C**	.	.	.	.	.	.	.	.	T	.	C	.	.	T	.	**C**	C	.	.	.	.	.	G	C	.	.	-	-	3	0
H 16	.	.	-	-	.	C	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	T	.	**C**	.	.	.	.	.	.	G	C	.	.	-	-	9	0
H 17	.	.	-	.	.	C	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	T	.	**C**	.	.	.	.	.	.	G	C	.	.	-	-	2	0
H 18	.	.	-	.	.	C	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	T	.	**T**	.	.	.	.	.	.	G	C	.	.	-	-	1	0
H 19	.	A	.	.	.	.	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	T	.	**C**	.	.	.	.	.	.	G	C	.	.	-	-	1	0
H 01	T	A	.	.	.	.	C	.	T	C	T	C	**-**	-	-	T	A	C	G	**C**	.	**C**	G	.	.	.	.	.	T	A	C	A	C	T	.	**C**	.	.	.	.	A	.	G	C	.	C	-	-	0	10
H 02	T	A	.	.	G	.	C	.	T	C	T	C	**-**	-	-	T	A	C	G	**C**	.	**C**	G	.	.	.	.	.	T	A	C	A	C	T	.	**C**	.	.	.	.	A	.	G	C	.	C	-	-	0	1
																																																Σ	**3 1**	**3 8**

between our two unconnected clades. More specifically, the genetical differences do not coincide with the supposed morphological differences between *T. glaucolepidea* and *T. percrenata.* Alternatively, these distant haplotypes could also represent paralogous ITS sequences. In the context of the present study we were unable to check for paralogs and hence conducted all of our analyses on two datasets, one including and one excluding H1 and H2. Excluding H1 and H2 reduces the number of polymorphic sites to 30.

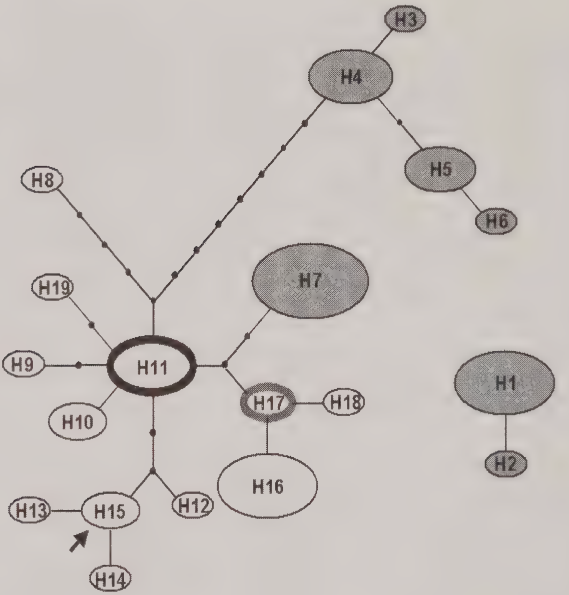

Fig. 1: Haplotype network of 69 ITS sequences from *Trapeliopsis glaucolepidea*. Ovals represent haplotypes sampled by us. The size of each oval is proportional to the number of sampled individuals of that haplotype. A line represents one mutational step. Black dots represent haplotypes not present in the sample. Haplotypes H1-H7 (grey) occur exclusively in Europe, H8-H19 (white) only in Latin America. The subnetwork consisting of haplotypes H1 and H2 is not connected to the main network under the 95% parsimony probability criterion. The minimum distance between both subnetworks is 21 steps. The black arrow indicates the probable connection between H1 and the large subnetwork. Bold marginal lines indicate alternative rooting positions of the large subnetwork: grey according to the algorithm by Castelloe & Templeton (1994), black according to the modified algorithm by Cassens et al. (2003).

Fig. 1 shows that Latin America and Europe do not share any haplotypes. However, the haplotypes from each continent do not form mutually monophyletic lineages. The European haplotype H7 clusters among the Latin American haplotypes close to the oldest – i.e. most interior – haplotypes of the network. The ancestral haplotype inferred by the algorithm of Castelloe & Templeton (1994) is the Ecuadorian H17 near the periphery of the cladogram. However, it has recently been emphasized that this algorithm is problematic when intermediate haplotypes are missing from the dataset or when the frequency of haplotypes is unequal over the geographical range of a species

(Cassens et al. 2003, Printzen et al. 2003). In our case the high outgroup weight of H17 is entirely due to the frequency of its immediate neighbour, H16, in the Ecuadorian population E1 (see below). With the modified algorithm by Cassens et al. (2003), by far the highest outgroup weight is assigned to H11 in the center of the network, which also occurs in Ecuador.

The genetic diversity indices for European and Latin American populations are summarized in Tab. 2. Two trends are obvious from the table. Firstly, the number of haplotypes is considerably higher in Latin America (12) than in Europe (5 or 7, including H1 and H2). Haplotype numbers differ also between single populations from different continents. Secondly, the inclusion of the deviating haplotypes H1 and H2 grossly inflates the nucleotide diversity but has relatively little effect on haplotype diversity. Although Latin America has a much higher number of haplotypes, the haplotype diversity is not significantly higher than for Europe (Tab. 3). It becomes significant only when H1 and H2 are removed from the European sample. A direct comparison of single Latin American and European populations indicates that only one European population (C3) displays a significantly lower diversity than the Latin American populations (Tab. 3).

Table 2: Number of observed haplotypes and diversity indices for two European and three Ecuadorian populations of *T. glaucolepidea*, all Latin American populations and European populations including and excluding the deviating haplotypes H1 and H2.

Population	N	No. of haplotypes	Haplotype diversity	π(JC)
Czech Rep. 1 (excl. H1-2)	12	4	0.636	0.0231
Czech Rep. 1 (excl. H1-2)	5	3	0.700	0.0015
Czech Rep. 3	7	2	0.286	0.0011
Ecuador 1	17	6	0.779	0.0015
Ecuador 2	7	5	0.857	0.0022
Ecuador 3	4	4	1.000	0.0038
Europe (incl. H1-2)	38	7	0.781	0.0205
Europe (excl. H1-2)	27	5	0.689	0.0096
Latin America	31	12	0.862	0.0036

The fact that no haplotypes are shared between Europe and Latin America is reflected by the high percentage of genetic variation between the continents. According to the results of the AMOVA (Tab. 4) all three hierarchical layers (among continents, among populations within continents and among individuals within populations) contribute more or less equally to the total genetic variance of our sample when H1 and H2 are included. When these haplotypes are excluded more than 70% of the total genetic variance is due to differences between the continents.

Morphological differences between the specimens are apparently not associated with genetic differences in the studied gene. Our results corroborate the opinion that *T. glaucolepidea* and *T. percrenata* are conspecific (Palice 1999). The ITS-sequences of British samples representing typical *T. glaucolepidea* are identical to some sequences from small, wood/peat-inhabiting morphotypes from Belgium, the Czech Republic, Germany, Poland and Sweden ("typical" *T. percrenata*).

Table 3: Comparison of haplotype diversity indices and significance of results according to a two-sided *t*-test. Significant differences (at the 0.05 level) are found between Latin America and Europe excluding H1 and H2, and Czech Rep. 3 and three Ecuadorian populations.

Population	Latin America	Ecuador 1	Ecuador 2	Ecuador 3
Europe (incl. H1-2)	0.14	-	-	-
Europe (excl. H1-2)	0.02 *	-	-	-
Czech Rep. 1 (incl. H1-2)	-	0.34	0.25	0.13
Czech Rep. 1 (excl. H1-2)	-	0.74	0.56	0.31
Czech Rep. 3	-	0.04 *	0.03 *	0.02 *

Discussion

The fact that there are no shared haplotypes among the two continents and the results of the AMOVA provide strong evidence against recurrent genetic exchange between Latin American and European populations of *T. glaucolepidea*. This is in line with the results of Printzen et al. (2003) who concluded that there is no evidence for recurrent gene flow between Western and Eastern North American and European populations of *Cavernularia hultenii*. However, it is still controversial, whether rare dispersal events in the distant past can account for the wide disjunctions displayed by many lichens. Recently, Högberg et al. (2002) reported evidence for a North American origin of European populations of *Letharia vulpina*. Their inference of long range dispersal is based on the fact that there is higher genetic variability in North America than is observed in European populations of *L. vulpina*. According to Högberg et al. (2002) the low diversity in European populations is best explained by a historical population bottleneck that was in turn the results of a founder event after long range dispersal from North America to Europe. A similar result – relatively low genetic diversity in European as compared to American populations – was reported by Printzen et al. (2003) and is also found here. We hesitate, however, to infer historical long range dispersal on the basis of these data. Low genetic variability in certain populations can be explained by population bottlenecks (Nei et al. 1975). However, there may be alternative explanations to a founder event through long range dispersal for such a bottleneck. Most boreal and temperate species of the Northern Hemisphere underwent pronounced population bottlenecks and changes of genetic diversity during the Pleistocene glaciations (e.g. Hewitt 1996, 1999, Soltis et al. 1997, Taberlet et al. 1998). These bottlenecks could have been more pronounced in Europe with its east-west extending mountain ranges than in North America. Their effects on tropical Latin American populations will certainly have been different from those on temperate European populations. The fact that European and Latin American haplotypes of *T. glaucolepidea* do not even form monophyletic lineages, would make it necessary to assume at least two independent events of historical long range dispersal, or to assume a very ancient dispersal event with subsequent lineage sorting between the continents. In our opinion, the data currently available on the genetic diversity of lichens is by far too poor which makes such assumptions largely speculative.

Table 4: Results of the AMOVA including the five populations Czech Rep. 1-2 and Ecuador 1-3 based on the total dataset and the dataset excluding haplotypes H1 and H2 (in **bold**).

Source of variation	d. f.	Sum of squares	Variance components	Percentage of variation
Among groups	1	77.421	2.32643 Va	32.58
	1	**73.793**	**4.07732 Va**	**73.16**
Among populations within groups	3	56.172	1.98713 Vb	27.62
	3	**14.338**	**0.55365 Vb**	**9.96**
Within populations	41	117.179	2.85801 Vc	39.73
	34	**31.079**	**0.91408 Vc**	**16.45**
Total	45	250.196	7.19361	
	38	**118.667**	**5.55712**	

It appears from our data that the number of haplotypes is higher in the tropics than in Europe. There is also a trend to higher haplotype diversity, however, direct comparisons between European and Latin American populations are mostly insignificant. These results reflect the fact that most Latin American haplotypes have only been collected once and should not be overinterpreted. Most of our tropical samples originate from only a small area. If some of the rare haplotypes are more common in other tropical areas, a more comprehensive sampling and sequencing effort would probably lead to a higher haplotype diversity in the tropics as could be expected from the number of haplotypes alone.

Nucleotide diversity Pi (π), however, is not necessarily affected in the same way. The pairwise, average distance between sequences depends largely on the distance between the most common haplotypes in a sample. In our case, the genetic distance between the most common European haplotypes (H1,) H4 and H7 is much larger than the distance between any of the Latin American haplotypes. We therefore conclude that nucleotide diversity is not a useful measure of genetic diversity, when comparing populations from different regions with non-overlapping haplotype composition.

Because closely related lichen species may be difficult to distinguish morphologically, species delimitations are often controversial in lichenology. For example, while some recent floras and checklists treat *T. glaucolepidea* and *T. percrenata* as different (Foucard 2001, Purvis et al. 1992, Søchting & Alstrup 2002), others suggest that both are identical (Hafellner & Türk 2001, Santesson et al. 2004, Vězda & Liška 1999). If morphological differences between species were associated with genetical differences, this would support the presence of two species instead of one. However, in our present dataset, morphologically different individuals often belong to the same haplotype, and morphologically similar ones are spread over the haplotype network.

A related question that has repeatedly been discussed in recent times is whether genetically differentiated populations of lichens form cryptic species (Grube & Kroken 2000, Kroken & Taylor 2001). The fact that European and Latin American populations are apparently isolated from each other could indicate the presence of two cryptic species. However, we caution against the over-use of the term "cryptic species" for every instance of genetic differentiation. Reproductive isolation may be a prerequisite for the formation of species but does not, in itself, constitute speciation. More genetical data from a broader range of markers and a more complete sampling over a wider geographical range would be necessary to assess the species status of temperate and tropical populations of *T. glaucolepidea*. At present, there is no evidence for cryptic speciation in our dataset.

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Appendix 1: Populations sampled for this study

Country	Haplotype(s)	Coordinates (WGS 84)	Collector (Herbarium)	N
Scotland	H7	56°40-45'N, 03°34-44'W	B.Buryová (hb. Palice 6962, 6975)	2
Ireland	H7	51°48'N, 09°27'W	J.Halda & Z.Palice (hb. Palice 8063b)	1
Netherlands	H5	52°15'N, 05°40'E	A.Aptroot 48260 (hb. Palice)	1
Belgium	H7	50°27-30'N, 06°06' E	B. & P. v.d.Boom 28370, 31546 (hb. Palice)	2
Germany	H1	48°55'N, 13°25'E	J.Halda et al. (hb. Palice 2672)	1
Germany	H7	52°15'N, 14°21'E	B. & P. v.d.Boom 28298 & H.Sipman (hb. v.d.Boom)	1
Germany	H7	50°06'N, 06°40'E	A.Aptroot 59313 (hb. Palice)	1
Sweden	H7	55°54'N, 13°33'E	Z.Palice (hb. Palice 8201)	1
Lithuania	H1	54°32'N, 23°49'E	P.Czarnota (GPN/3117)	1
Poland	H2	53°40'N, 18°15'E	P.Czarnota (GPN/2961)	1
Poland	H1	53°33'N, 17°43'E	P.Czarnota (GPN/3205)	1
Poland	H7	50°49'N, 15°22'E	P.Czarnota (hb. Palice, dupl. ex GPN/3345)	1
Poland	H7	49°10'N, 20°05'E	P.Czarnota (GPN/2894)	1
Czech Rep. - **C1**	H1, H4, H5, H6	48°41-55'N, 13°50'-14°03'30"E	Z.Palice (hb. Palice 1481, 1601, 4212, 4850, 5094, 5101, 6818, 7036, 8630, 8631, 8632, 8633)	12
Czech Rep. - **C2**	H7	49°05'N, 13°31-34'E	Z.Palice, O.Peksa (hb. Palice 6551, 8629)	2
Czech Rep. - **C3**	H4, H5	50°53-54'N, 14°23-25'E	Z.Palice (hb. Palice 5808, 5814, 5831, 6832, 6834, 8605, 8606)	7
Czech Rep. - **C4**	H3, H7	49°38-40'N, 15°53'-16°04'E	Z.Palice & O.Peksa (hb. Palice 8066, 8067)	2
Ecuador - **E1**	H9, H10, H11, H16, H17, H19	00°48-49'N, 77°55-57'W	Z.Palice (hb. Palice 2312, 2323, 3065a, 3065b, 3255, 8494, 8495, 8496, 8497, 8499, 8503, 8505, 8507, 8508, 8509, 8515, 8519)	17
Ecuador - **E2**	H11, H15, H16, H17, H18	01°07-17'S, 78°19-21'W	Z.Palice (hb. Palice 4336, 4348, 8504, 8511, 8512, 8513, 8524)	7
Ecuador - **E3**	H12, H13, H14, H15	04°08-11'S, 79°06-10'W	Z.Palice (hb. Palice 2707, 3149, 3578, 3781)	4
Ecuador - **E4**	H15	01°41'S, 78°27'W	Z.Palice (hb. Palice 3203)	1
Ecuador - **E5**	H16	00°18'S, 78°12'W	Z.Palice (hb. Palice 2234)	1
Costa Rica	H8	09°34'N, 83°45'W	H.Sipman 11792 (B)	1

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New and rare rust fungi *(Uredinales)* from Anatolia (Turkey) - 2

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Abstract—Twenty-two rust taxa are reported from Anatolia in Turkey. Three of them are described as new species, *Phragmidium sarcopoterii* on *Sarcopoterium spinosum, Puccinia onosmaticola* on *Onosma molle* and *Uromyces dorystoechadis* on *Dorystoechas hastata. Puccinia tepperi* on *Phragmites australis* is reported for the first time outside Australia while four other taxa are reported for the first time in Turkey: *Ochropsora ariae* on *Anemone blanda, Frommeëlla tormentillae* on *Potentilla* sp. and *Puccinia constricta* on *Teucrium orientale*. Some new hosts for previously known species in Turkey are reported.

Key words—microfungi, new taxa, parasite

Introduction

As Bahcecioglu & Gjærum (2003) have previously observed, Turkish mycota is rich in microfungi. Some research has been done, e.g. by Karel (1958) and Henderson (1959, 1961, 1964), but there is still much to do.

Materials and methods

The material presented here was collected in the years 1995-2002 in the following provinces: Ağrı, Anamur, Antalya, Bitlis, Erzincan, Erzurum, Gümüshane, Kahramanmaras, Malatya, Ordu and Sivas. Spores were mounted in lactophenol. The host names follow the Flora of Turkey and Aegean Islands by Davis (1968 – 1985) and Davis et al. (1988). After identification of the rusts the material is preserved in the herbarium of Inönü University.

Frommeëlla tormentillae (Fuckel) Cummins & Y. Hirats. – Illustrated genera of rust fungi. Rev. ed., p. 120, 1983.

Syn. *Frommea obtusa* (Fuckel) Arthur. – Bull. Torrey Bot. Club 44: 503, 1917.
On *Potentilla* sp. (Rosaceae).

Gümüşhane. Zigana Pass, 1950-2000 m, 12. Aug. 2001, Z. Bahcecioglu 3228, II+III.

Uredinia hypophyllous, pale yellow with a few clavate, thin-walled paraphyses. Urediniospores 19-22 x 16-20 μm, subgloboid, ellipsoid or obovoid, walls 1 (-1.5) μm thick, hyaline, finely echinulate with 3-4 indistinct pores. Telia hypophyllous, brown. Teliospores 54-84 x 27-32 μm, cylindric or clavate, 3-6-celled, mostly 5, with one pore in each cell, walls brown, smooth, at side 4-5 μm thick, apically thickened to 4.5-6.5 μm, mostly rounded, but often with a short papilla. Pedicels persistent, equal to the length of the spores, hyaline but tinted near the spore, collapsing.

As *Frommea obtusa,* this rust has been reported on many species of *Potentilla* in Europe and the Americas, more rarely in Africa and Australia. In Asia it is reported from Armenia, India and Siberia. *Frommeëlla* is a new genus in the Turkish rust flora.

Ochropsora ariae (Fuckel) Ramsb. – Trans. Brit. Mycol. Soc. 4: 337, 1915.
On *Anemone blanda* Schott & Kotschy. (Ranunculaceae).

Malatya. Beydağı. Bürücek hill, 2000 m, 01. May. 1995, Z. Bahcecioglu 179, 0+I.

Pycnia epiphyllous, type 7. Aecia amphigenous, mostly hypophyllous, covering the whole leaf, cupulate, peridium white. Aeciospores in chains, 14-20(-23) x 14-17 μm, ellipsoid or globoid, often somewhat angular, walls c 1 μm thick, densely and finely verrucose, hyaline.

This rust species, systemic in the rootstocks and host alternating with species of *Sorbus*, occurs on many species of *Anemone* from Europe to China and Japan. Woronow (1910) and Durrieu (1968) reported *A. blanda* as a host for this rust from Caucasus and Greece, respectively, both as *O. sorbi* (Oud.) Dietel. *Ochropsora* is a new genus to the rust flora of Turkey.

Phragmidium sarcopoterii Gjærum & Bahcecioglu, *sp. nov.* (Fig. 1).
Etymology: from *Sarcopoterium,* a genus in Rosaceae.

Pycnia, aecia et uredinia ignota. Telia hypophylla, atrofusca cum paraphysibus clavatis vel cylindricis, pariete 1-1.5 μm crasso, hyalino. Teliosporae 47-80 x 31-39 μm, (3-)4-5(-6)- cellularis, cylindraceae, ad basem leviter dilatatae, ad apicem rotundatae, papillis hyalino vel apiculato verrucoso usque ad 15 μm longo, pariete 4-4.5 μm crasso, ad apicem 4.5-5.5μm incrassato, verrucis disperso, hyalino, quaque cellula poris duobus, cellulae apicalis raro tribus instructis, pedicello persistente, usque ad 90 μm longo, vulgo deorsum incrassato, hyalino.

Pycnia, aecia and uredia not seen. Telia hypophyllous, blackish brown with clavate to curved paraphyses, walls hyaline, 1-1.5 μm thick. Teliospores 47-80 x 31-39 μm, (3-)4-5(-6)-celled, cylindric, slightly wider at base, apically rounded with a low, hyaline papilla or often with a warted, abrupt apiculus up to 15 μm long, walls 4-4.5 μm thick, brown, apically thickened to 4.5-5.5 μm, with scattered, hyaline warts, each cell with 2 pores, apical cells rarely with 3 pores. Pedicels up to 90 μm long, generally swelling at base, hyaline.

Holotype: Z. Bahcecioglu 2674 (Inönü), Turkey, Anamur, Between Anamur and Gazipaşa, Kaledran village, 50 m, 28. May. 2000, on *Sarcopoterium spinosum* (L.) Spach. (Rosaceae). Isotype in NCRI.

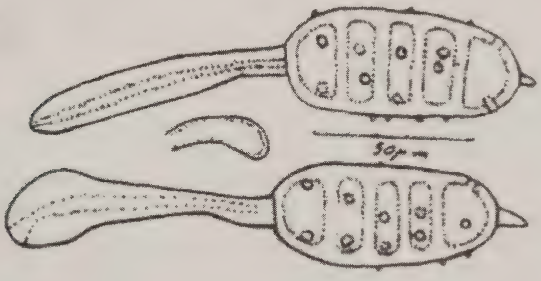

Fig. 1. *Phragmidium sarcopoterii* . Teliospores and paraphyses from type.

The teliospores in the present specimen differ from those in *Phr. sanguisorbae* (DC.) J. Schröt. ssp. *mediterranea* D. M. Henders. in having thicher walls with scattered warts and often an apiculus and with pedicels longer than the spores.

Phr. sanguineum (DC.) J. Schröt. has been reported on the present host from Libya, Greece and Israel. The ssp. *mediterranea* is reported from Spain to Greece.

Puccinia calcitrapae DC. – Fl. Fr. 2: 221, 1805.

Syn. *P. echinopis* DC. – Fl. Fr. 5: 57, 1815.
On *Echinops galeticus* Freyn. (Asteraceae).
Sivas. İmranlı, Saruhan village, 2000 m, 16.Aug. 2002, Z. Bahcecioglu 3352, (II+) III.
On *Echinops melitenensis* Hedge & Hub.- Mor.
Sivas. Gürün, Gökpınar, 1400 m, 16. Aug. 2002, Z. Bahcecioglu 3326, (II+) III.

Uredinia not seen, but some spores have been found in the telia. Urediniospores 26-34 x 26-31 μm, ellipsoid or subgloboid, walls 1.5-3 μm thick, slightly thickened basically, yellowish brown, echinulate with 3 equatorial pores. Telia amphigenous, mostly hypophyllous, black, small, round, often in rings around a central sorus. Teliospores 33-43(-46) x 23-27 μm, cylindrical, ellipsoid or obovoid, walls 3 μm thick, apically rarely thickened up to 4.5-5 μm, apically rounded, flattened or attenuate, verruculose, brown, upper pore apical or subapical, lower pore somewhat depressed. Pedicels short, hyaline.

P. echinopis is widespread in Central and South Europe through Asia to China, but not in more tropical areas. In Africa it is reported from Morocco, Algeria and Sudan. From Turkey it has been reported as *P. echinopis* on many species of *Echinops* as *E. heldreichii* Boiss., *E.* aff. *viscosus* DC. (Henderson 1961) and *E. melitenensis* Hedge & Hub.- Mor. and *E. purgans* Trautv., *E. ritro* L. (Bahcecioglu & Isiloglu 1996, Bahcecioglu & Yildiz 2001). For other asteraceous genera serving as hosts for this rust see e.g. Henderson (1964). *P. echinopis* is now recognized as a race or a f. sp. of *P. calcitrapae* s. lat.

Puccinia caricina DC. s. lat. – Fr. Fl. 5: 60, 1815.

On *Carex* sp. (Cyperaceae).

Ordu. Between Ordu and Aybastı, 1500-1600 m, 17. Aug. 2001, Z. Bahcecioglu 3325, II+III.

Uredinia hypophyllous, oblong, often confluent, covered by epidermis which later cracks, brown. Urediniospores 27-33 x 17-25 μm, subgloboid, ovoid or obovoid, walls 1.5-2.5 μm thick, yellow, echinulate, with 3 equatorial pores, covered by low, hyaline papillae. Telia mainly hypophyllous, oblong, often confluent, covered by epidermis which later cracks, dark brown. Teliospores 47-65 x 15-22 μm, clavate, slightly constricted, apically rounded or obtuse, walls brown, in lower cells about 1 μm thick, in upper cells 1.5 μm thick, apically thickend up to 10 μm, smooth, upper pore apical, lower near septum. Pedicels persistent, pale brown, up to 25 μm long.

P. caricina is reported from all continents, common on many species of *Carex* in Europe, but also in Asia and in the Americas, more rarely in Africa and Australia. The first report of this rust from Turkey was given by Magnus (1903) who reported it as *P. caricis* (Schum.) Rebent. on *C. hirta* L. Later Henderson (1964) and Bahcecioglu & Gjærum (2003) reported it on *C. hordeistichos* Vill., Henderson also on *C. sylvatica* Huds.

Puccinia chaerophylli Purton. – Midland Flora 3: 303, 1821.

On *Chaerophyllum macrospermum* (Sprengel) Fisch. & Mey. (Apiaceae).

Gümüşhane. Zigana Pass, 1600 m, 12.Aug.2001, Z. Bahcecioglu 3219, II+III.

Uredinia hypophyllous, rounded or oblong, yellowish brown. Urediniospores 21-27 x 20-23 μm, subgloboid or ellipsoid, walls 1.5-2.5 μm thick, pale yellow or yellowish brown, echinulate with 3 equatorial pores covered by low, hyaline papillae. Telia amphigenous, mostly hypophyllous, blackish brown. Teliospores 23-36 x 17-25 μm, ellipsoid or obovoid, often irregular, rounded at both ends or apically obtuse or attenuate below, slightly constricted, walls 2-2.5 μm thick, reticulate, yellowish brown to brown, upper pore apical, lower pore subequatorial. Pedicels hyaline, short.

P. chaerophylli is common in Europe and Asia except in tropical areas, rare in Africa. In Turkey it has previously been reported on *Anthriscus nemorosus* (Bieb.) Sprengel (Tamer & Öner 1978), *Chaerophyllum byzantinum* Boiss. (Gjærum 1996) and *C. bulbosum* L. (Bahcecioglu & Yildiz 1996). *C. macrospermum* is a new host for this rust.

Puccinia constricta (Lagerh.) Bubák. – Centralbl. f. Bacteriol., Parasitenk., Infektionskrankh. II. Abt. 9: 919, 1902.

On *Teucrium orientale* L. (Lamiaceae).

Kahramanmaraş. Göksun, Ahmetcik village, 1300 m, 08. Aug. 2001, Z. Bahcecioglu 3187, III.

Telia on leaves and stems, dark brown. Teliospores 39-48 x 20-31 μm, ellipsoid, upper cells mainly slightly wider than the lower ones, slightly constricted, rounded in both ends or apically slightly attenuate, walls 1-1.5 μm thick, in upper cells gradually thickened to 7 μm, brown, in lower cells slightly paler. Pedicels up to 65 μm long, pale brown, collapsing.

Guyot & Massenot (1952) separated the rusts on *Teucrium* in two groups, one with pale to reddish brown telia mainly on leaves, the other with blackish brown telia mainly on stems, but also on leaves. In the latter group they recognized *P. constricta, P. istriaca* P. Syd. & Syd. and *P. polii* Guyot. They found *P. majoricensis* Maire similar to *P. polii* which is the younger name of these two, but they kept them under *P. polii*. Petrak (1953) and Jørstad (1962) used *P. majoricensis* with *P. polii* as a synonym.

P. majoricensis has longer teliospores than both *P. constricta* and *P. istriaca* which hardly can be separated that way as they overlap. However, *P. constricta* has pedicels equal to the length of spores while *P. istriaca* has short pedicels. Our specimen has teliospores whose pedicels are equal or even longer than the spores. We have therefore placed it under *P. constricta* which is known in Central Europe from France to Romania and Bulgaria and also in Caucasia. It is new to the rust flora of Turkey.

Puccinia hieracii Mart. var. **piloselloidarum** (Probst) Jørst. – Kgl. Norske Vidensk. Selsk. Skr. 1935, 38: 27, 1936.

On *Pilosella* x *auriculoides* (A. F. Lang) Sell & West. (Asteraceae).
Erzincan. Kemaliye, Sırakonaklar village, 1300 m, 24. Jun. 2000, Z. Bahceciolglu 2924, II+III.
On *Pilosella verruculata* (Link) Sojak.

Erzincan. Kemaliye, Sırakonaklar village, 1600 m, 24.Jun.2000 m, Z. Bahcecioglu 2936, II+III.

Uredinia hypophyllous, brown. Urediniospores 27-31 x 23-29 μm, subgloboid, ovoid or obovoid, walls 1.5-2.5 μm thick with two pores slightly superequatorial, brown, echinulate. Telia hypophyllous, brown. Teliospores 35-46 x 22-27 μm, ellipsoid or obovoid, somewhat irregular, some spores slightly constricted, walls 2-2.5 μm thick, brown, finely verruculose, upper pore subapical, the lower pore equatorial, pedicels hyaline, short, mostly broken near the spore.

P. hieracii, living on species of many asteraceous genera, is a complex species of which some races or forms have been described as species or varieties, all with two pores more or less superequatorial. *P. hieracii* var. *piloselloidarum* is bound to the *Pilosella* and morphologically characterized by Urediniospors with slightly superequatorial germ pores.

P. hieracii is reported from Turkey by e.g. Magnus (1903), Henderson (1961, 1964) and Bahcecioglu and Yildiz (2001) while Tamer et al. (1987) published the variety on *Pilosella x auriculoides*

Puccinia lapsanae Fuckel. – Jahrb. Nass. Ver. Nat. p. 13, 1860.

On *Lapsana communis* L. (Asteraceae).

Sivas. Kızıldağ Pass, 2100 m, 14. Aug. 1996, Z. Bahcecioglu 1134, II+III; Erzincan. Kemaliye, Sırakonaklar village, 1600 m, 24. Jun. 2000, Z. Bahcecioglu 2941, II+III; Gümüşhane. Torul, between Zigana village and Zigana Pass, 1600 m, 08.12.2001, Z. Bahcecioglu 3225, II+III.

Uredinia and telia amphigenous, brown, small, often confluent. For the specimens 1134 and 2941 urediniospores 22-26 x 16-22 μm, globoid or subgloboid, walls 1-1.5 μm thick, pale brown, verruculose with 2 equatorial pores. Teliospores 27-35 x 22-25(-27) μm, ellipsoid or obovoid, walls 1.5 - 2(-2.5) μm thick, brown, upper pore apical, lower equatorial. Pedicels short, hyaline, deciduous.

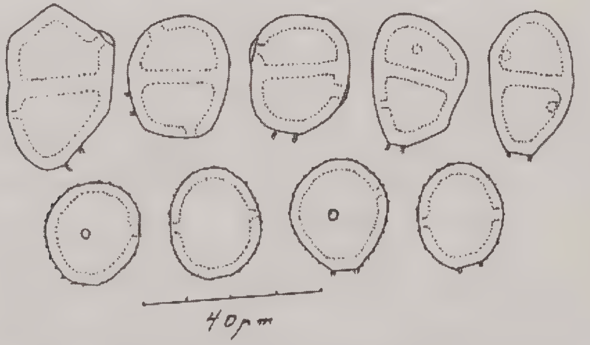

Fig. 2. *Puccinia lapsanae*. Telio- and urediniospores from specimen Z. Bahcecioglu 3225.

In the specimen 3225 uredinio- and teliospores have slightly thicker walls and the teliospores (Fig. 2) are often more irregular than in the two other specimens studied. Henderson (1964) mentioned that in S. W. Asia teliospore-walls often are slightly thickened compared to the normal, probably correlated with the regional arid conditions. However, for describing the fungus on No. 3225 e. g. as a new variety we think more material is necessary.

P. lapsanae is common in Europe, but seems to be rare in the other continents. Bahcecioglu & Isiloglu (1996) and Bahcecioglu & Yildiz (2001) reported it on *L. communis* and *Jurinea consanguinea* L. from the Malatya province.

Puccinia libani Magn. – Verh. Zool.-Bot. Ges. Wien 1: 442, 1900.

On *Prangos pabularia* Lindl. (Apiaceae).

Sivas. 32 km from Gürün to Pınarbaşı, 1800 m, 06. Jun. 1997, Z. Bahcecioglu 1686 m, I+III.

Pycnia not seen. Aecia epiphyllous in long groups, peridial cells rhomboid, 23-39 x 15-20 μm, inner walls verrucose, outer walls smooth, both 6-6.5 μm thick. Aeciospores 21-35 x 19-25 μm, ellipsoid or subgloboid, walls less than 1 μm thick, densely verruculose, hyaline. Telia epiphyllous, round or oblong, often confluent or connected with the aecia, dark brown. Teliospores 56-72 x (23-)28-35 μm, clavoid, somewhat constricted at septum, walls about 1 μm thick, apically thickened up to 11 μm, apically rounded or truncate, reddish brown or brown, basically yellowish brown, smooth, upper pore apical, lower pore obscure. Pedicels tinted, short. One-celled spores occur.

The rust is known from Greece and Lebanon east to Kazakhstan. Lindroth (1902) made the first record of this rust in Turkey on *P. uechtritzii* Boiss. & Hausskn. Henderson (1959, 1964) added *P. ferulacea* Lindl., *P. lophoptera* Boiss. and also *Peucedanum pisidicum* Boiss. *P. pabularia* is a new host for this rust.

Puccinia onosmaticola Gjærum & Bahcecioglu, *sp. nov.* (Fig. 3).

Etymology: from *Onosma*, a genus in Boraginaceae.

Pycnia, aecidia et uredinia ignota. Telia hypophylla, dispersa, parva, pulverulenta, brunnea. Teliosporae 22-34(-39) x 17-22 μm, ellipsoideae, ad basem raro attenuatae, pariete 3-4 μm crasso, laeve, brunneo, poro superiore subapicali, poro inferiore aequatorio instructis, pedicello brevi, pariete tenui, leviter tinto.

Pycnia, aecia and uredinia not seen. Telia hypophyllous, scattered, small, pulverulent, brown. Teliospores 22-34(-39) x 17-22 μm, ellipsoid, rarely obovoid, rounded at both ends or rarely attenuate at the base, walls 3-4 μm thick, smooth, brown, upper pore subapical, lower equatorial. Pedicels short, slightly tinted.

Holotype: Z. Bahcecioglu 2054 (Inönü), Turkey, Sivas, Gürün, Gökpınar, 1500 m, 18. Jul. 1998, on *Onosma molle* DC. (Boraginaceae). Isotype in NCRI.

The teliospores of this species are shorter with evenly thick walls and the lower pore equatorial while teliospores in *P. onosmatis* Gjærum & Bahcecioglu are thickened apically and with the lower pore near septum.

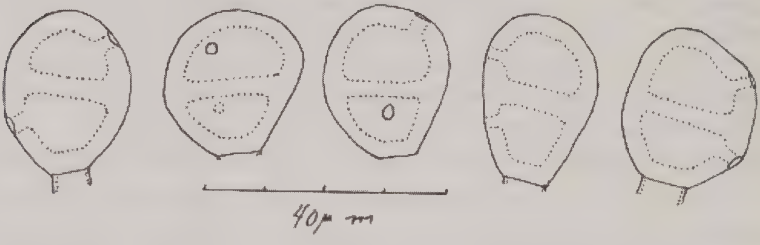

Fig. 3. *Puccinia onosmaticola*. Teliospores from type.

Puccinia pulvinata Rabenh. – Hedwigia 10: 20, 1871.

On *Echinops ritro* L. (Asteraceae).
Sivas. Gürün, Suğul valley, 1400 m, 02. Oct. 2002, Z. Bahcecioglu 3426, II+III.
On *Echinops* sp.
Anamur. Between Anamur and Gazipasa, 50 m, 28. May. 2000, Z. Bahcecioglu 2673, (II+)III.

Uredinia hypophyllous, yellowish brown. Urediniospores 37-45 x 34-39 μm, subgloboid, walls 2-3 μm thick, yellowish brown, apically thickened up to 4.5 μm, at the base up to 4 μm, echinulate, 3-4 equatorial pores covered by wide, hyaline papillae. Telia amphigenous, pulverulent, dark brown. Teliospores 50-63 x 31-39 μm, ellipsoid or ovoid, walls 2-4(-4.5) μm thick, apically thickened up to 5.5 μm, brown, paler above the apical pore, lower pore equatorial, very finely verruculose, easiest to see on dry spores. Pedicels at least up to 130 μm long, in the literature given up to 190 μm (Kapsanaki-Gotsi 1986). One-celled spores occur.

P. pulvinata has been reported scattered from Morocco and Algeria east to Iran and Pakistan. From Turkey it has been reported on *E. heldreichii* Boiss. (Magnus 1903) and on *E. viscosus* DC. (Henderson 1964). *E. ritro* seems to be a new host for this rust species. Other Turkish hosts are *Jurinea depressa* C. A. Mey. var. *pinnatiseta* Boiss. and *J. pontica* Hausskn. & Freyn. (Henderson op. cit.) and *Acantholepis orientalis* Less. (Gjærum 1996).

Puccinia recondita Roberge ex Desm. – Bull. Soc. bot. Fr. 4: 798, 1857.

On *Cerinthe minor* L. (Boraginaceae).
Sivas. Taşlıdere, 1300 m, 03. Jun. 1997, Z. Bahcecioglu 1531, 0+I.
On *Myosatis lithospermifolia* (willd.) Hornem. (Boraginaceae).
Sivas. Divriği, Höbek village, 1300 m, 02.06.1997, Z. Bahcecioglu 1484, 0+l.

Pycnia epiphyllous, type 4, and aecia in groups around the pycnia, peridia white, peridial cells 35 x 10-20 μm, outer walls 8-10 μm thick, striate, inner walls 2-3 μm, verrucose. Aeciospores 25-33 x 21-29 μm, subgloboid, ovoid or ellipsoid, often somewhat angular, walls hyaline, c 1 μm thick, finely verrucose, pores scattered, obscure.

These aecial stages most likely belong to the aggregate species *P. recondita* which has its aecial stage on species of different genera of Boraginaceae, Balsaminaceae, Hydrophyllaceae and Ranunculaceae. From Turkey it has been reported as *Aecidium asperifolii* Pers. under *P. rubigo-vera* (DC.) Winter on *Nonnea macrocarpa* Boiss. & Heldr. and on *Anchusa angustissima* C. Koch by Magnus (1891) and as *P. agropyri* Ell. & Ev. on *Clematis cirrhosa* L. by Bremer et al. (1952). Henderson (1959, 1964) reported it as *A. asperifolii* on *Moltkia caerulea* (Willd.) Lehm. and under *P. recondita* on *Clematis orientalis* L. If belonging to *P. recondita* s. lat. *Cerinthe* and *Myosotis* are new host genera for this rust in Turkey.

Puccinia serpylli Lindr. – Acta Soc. Fauna Flora Fennica 26: 10, 1904.

On *Thymus fallax* Fisch. & Mey. (Lamiaceae).
Ağrı. Eleskirt, Tahir mountain, 2400 m, 21.Jul..2000, B. Yildiz 14853, III; Bitlis. Tatvan, Nemrut mountain, 1750 m, 17.Jul. 2000, B. Yildiz 14802 , III.
On *Thymus fedtschenkoi* Ronninger.
Bitlis. Tatvan, Nemrut mountain, 1750 m, 17. Jul. 2000, B. Yildiz 14796, III.
On *Thymus kotschyanus* Boiss. & Hohen.
Bitlis. Tatvan, Nemrut mountain, 1750 m, 17. Jul. 2000, B. Yildiz 14801, III.

Telia hypophyllous, blackish brown, round or ellipsoid, scattered or in small groups, pulverulent. Teliospores 39-53 x 22-29 μm, ellipsoid or obovoid, mostly rounded apically, constricted at septum, walls 1-1.5 μm thick, apically thickened up to 8 μm, smooth, brown. Pedicels up to 115 μm long, thin-walled, hyaline but tinted near the spore, persistent.

P. serpylli is microcyclic. It has been found scattered on a few species of *Thymus* from Finland and Kola in Russia to Mongolia. Henderson (1959) reported it on *P. kotschyanus* from Turkey, and it has also been reported on the same host from Iran (Petrak 1953). *T. fallax* is a new host for the rust.

Henderson (op. cit.) pointed out the similarity to *P. stipina* Tranz. f. sp. *thymi-stipae* Kleb. and indicated it might has been derived from this longcyclic species, alternating between *Thymus* (0+I) and *Stipa* (II+III).

Puccinia stipae Arthur var. stipina (Tranzschel) H. C. Green & Cummins. – Mycologia 50: 21, 1958.

Syn. *Puccinia stipina* Tranzschel – Trav. Mus. Bot. Acad. Imp. Sci. St. Petersb. 7: 114, 1909 (nom. nud).

On *Thymus kotschyanus* Boiss. & Hohen. (Lamiaceae).

Malatya. Arapkir road, Karayaollari bakımevi, 26. Jun. 1999, 1100 m, B. Yildiz 14356, I.

Pycnia amphigenous, type 4. Aecia hypophyllous, in dense groups. Peridia white, long, peridial cells polygonal, 20-40 x 10-12 μm, outer walls up to 8 μm thick, striate, inner walls up to 2 μm, verrucose. Aeciospores 21-27 x 16-19 μm, subgloboid, oblong or ellipsoid, often irregular, walls 1.5-2.5(-4) μm thick, sometimes unevenly thickened, verrucolose, yellowish brown, pores obscure.

P. menthae Pers. has also been reported with aecia on *Thymus,* but its aeciospore-walls are hyaline.

This taxon is host-alternating between species of *Stipa* (II+III) and species of many lamiaceous genera. On *Thymus* spp. the aecial stage is fairly common in Central and South Europe, but it seems to be very rare in Asia, reported only from Kazakhstan. Tamer et al. (1990) and Güven & Tamer (1993) published it from Turkey. *T. kotschyanus* is a new host for this taxon.

Puccinia tepperi F. Ludw. – Zeitschr. Pflanzenkr. 2: 132, 1892.

On *Phragmites australis* (Cav.) Trin. ex Steudel. (*Poaceae).*

Malatya. 15 km from Malatya to Sivas, 900 m, 19. Jun. 2002, Z. Bahcecioglu 3332, III.

Telia amphigenous, confluent, densely covering large areas of the leaves, brown. Teliospores 43-70 x 21-26(-30) μm, obovoid, ellipsoid or more rarely fusiform, slightly constricted, walls 2.5-4.5 μm, apically thickened to 8.5 μm, yellowish brown, apically paler, smooth, upper pore apical, the lower near septum. Pedicels persistent, thick-walled, not collapsing, up to 220 μm long. It differs from *P. moriokaensis* S. Ito and *P. invenusta* P. Syd. & Syd. on the same host, respectively, wider and longer teliospores.

P. tepperi is macroscopically separated from other species of *Puccinia* on *Phragmites* as the teliospores are confluent in large, compact groups adaxially on the leaves.

This fungus is so far known only from to the type locality, Grange in South Australia. Cummins (1971) when examining the type (S), found two urediniospores. We have seen none.

Trachyspora intrusa (Grev.) Arthur. – Manual of the rusts in United States and Canada, p. 97, 1934.

On *Alchemilla barbatiflora* Juzep. (*Rosaceae*).

Gümüşhane. Zigana Pass, 1600 m, 12. Aug. 2001, Z. Bahcecioglu 3215, III.

On *Alchemilla mollis* (Buser) Rothm.

Sivas. Şerefiye, Armutcayırı village, 1500 m, 16. Aug. 2002, Z. Bahcecioglu 3343, III.

Telia hypophyllous, sori small, surrounded by the epidermis, often confluent, brown. Teliospores 23-35(-43) x (18-)22-27 µm, globoid, obovoid or oblong, walls 2-2.5 µm thick, upper part coarsely verrucose, lower part smooth or nearly so, brown. Pedicels hyaline, 1-septate, upper cells shorter than the lower ones, deciduous.

This rust is widespread in the northern hemisphere. From Turkey it has previously been reported as *T. alchemillae* (Pers.) Fuckel on *A. acutiloba* Stev. by Maire (1906) and as *Uromyces alchemillae* (Pers.) Fuckel on *A.. vulgaris* L. by Magnus (1891). As *A. intrusa* it was published by Henderson (1964) on *A. vulgaris* L. agg., by Tamer et al. (1989) on *A. pseudo-castalini* Juzep. and Bahcecioglu (2004) on *A. holocycla* Rothm.

Uromyces dorystoechadis Gjærum & Bahcecioglu, *sp. nov.* (Fig. 4).

Etymology: from *Dorystoechas,* a genus in *Lamiaceae.*

Pycnia, aecidia et uredinia ignota. Telia hypophylla, parva, dispersa, fusca. Teliosporae 28-31 x 27-30 µm, globoideae, subgloboideae, ellipsoideae vel globoideae-angulares, pariete 3.5-4 µm crasso, fusco, laeve, poro apicalis. Pedicella usque ad 240 µm longi, hyalini.

Pycnia, aecia and uredinia not seen. Telia hypophyllous, small, scattered, dark brown. Teliospores 28-31 x 27-30 µm, globoid, subgloboid or ellipsoid, rarely globoid-angular. Walls evenly 3.5-4 µm thick, dark brown, smooth, pore apical. Pedicels up to 240 µm long, hyaline.

Holotype: Zeliha Bahcecioglu 2892b (Inönü), Turkey, Antalya, Kemer – Göymük, Değirmendere, 50 m, 29. May. 2000, on *Dorystoechas hastata* Boiss. & Heldr. ex Benth. (Lamiaceae). Isotype in NCRI.

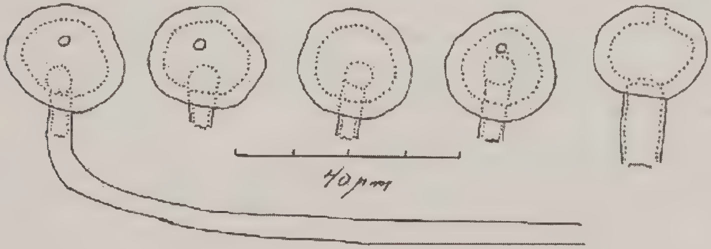

Fig. 4. *Uromyces dorystoechadis* Teliospores from typ.

To our knowledge no rust has previously been described on this genus. It differs from other *Uromyces* species on lamiaceous hosts having teliospores with evenly thickened walls, the others are thickened apically.

Uromyces fallens (Arthur) Kern ex Barth. – Handb. N. Amer. Ured. p. 61,1928.

On *Trifolium pratense* L. (*Fabaceae*).

Gümüşhane. Zigana Pass, 1600 m, 12. Aug. .2001, Z. Bahcecioglu 3221a, II.

Uredinia amphigenous, round, coalescent, brown. Urediniospores (17-)22-30 x 20-24 µm, subgloboid, ellipsoid, obovoid, often somewhat irregular, walls (1.5-)2-2.5 thick, yellowish brown, 3-5(-6) pores scattered or 2-4 equatorial and one apical, echinulate.

This rust is widespread, occurring on many species of *Trifolium*, but seems to be new to the rust flora of Turkey. Cummins (1977) recognized it as a variety of *Uromyces trifolii-repentis* Liro, *U. trifolii-repentis* var. *fallens* (Arthur) Cummins.

Uromyces punctatus J. Schröt. – Abh. Schles. Ges. Vaterl. Cult. Nat. Abh. 1869-72, 1870.

On *Astragalus densifolius* Lam. *(Fabaceae)*.

Erzincan. Kemaliye, Sırakonaklar village, 1600 m, 24. Jun. .2000, Z. Bahcecioglu 2942, III.

Uredinia mostly epiphyllous, round or oblong, on stems in long streaks, pale brown. Urediniospores 22-29 x 20-23 µm, obovoid, subgloboid, often angular, walls 1.5-2 µm thick, pale brown with 3-4 pores , when 3 often equatorial, with low, hyaline papillae, echinulate. Telia as the uredinia, but blackish brown. Teliospores 21-28 x 17-20 µm, ellipsoid, obovoid or somewhat irregular, walls 1-1.5 µm, dark brown, verrucose, verrucae often in lines, pore apical, often with a low, hyaline papilla. Pedicels short, hyaline, deciduous.

U. punctatus has been recorded on more than one hundred species of *Astragalus* (Gjærum 1991) and occurs also on species of *Oxytropis*. *A. densifolius* is a new host for this taxon which is often recognized as a race of *U. pisi* (DC.) Otth (cfr. Henderson 1964). Henderson (1961) reported this rust on *A. gummifer* Lab. and *A. sp*. from Turkey.

Uromyces scleranthi Rostr. – Bot. Tidsskr. 21: 40, 1897.

Syn. *Urom. alsines* Tranzschel. – Ann. Mycol. 5: 547, 1907.
On *Minuartia hamata* (Hausskn.) Mattf. (Caryophyllaceae).

Malatya. 10 km from Malatya to Arapkir, 1600 m, 24. Jun. 2000, Z. Bahcecioglu 2910, III.

Telia hypophyllous, blackish brown. Teliospores 20-25 x 15-21 µm, subgloboid, ellipsoid or obovoid, often somewhat irregular, walls 1.5-2 µm thick, pale brown, apically slightly thickened with a wide, hyaline cap over the apical pore, finely verrucose. Pedicels hyaline, deciduous.

The size of the teliospores in this specimen corresponds fairly well to what is given in the diagnosis, but they have slightly thinner walls.

On species of *Minuartia (Alsine)* this rust has been reported from Bulgaria, Russia (Crimea) and Iran. Bahcecioglu (2001) reported it from Turkey on *M. meyeri* (Boiss.) Born. and *M. hamata*. On *Scleranthus* spp. it has been reported from Denmark, France, Hungary, Russia and Australia.

Zaghouania phillyreae Pat. – Bull. Soc. Myc. Fr. 17: 187, 1901.

On *Phillyrea latifolia* L. *(Oleaceae).*

Antalya. 3 km from Antalya to Gebiz, 100 m, 22. May. 2000, Z. Bahcecioglu 2687, I.

Pycnia not seen. Aecia on stems, amphigenous on malformed, thickened leaves, pustulate, covered by epidermis, orange, peridium short. Aeciospores 18-25 x 15-19 μm, subgloboid or ellipsoid, walls 2-2.5 μm thick, hyaline, alveolate-reticulate.

Z. phillyreae has been reported on *Phillyrea* in South England (cult.) and in the Mediterranean from Morocco, Algeria and Portugal to Israel. On species of *Osmanthus* it has been reported from China and Japan. Zaghouania is a new genus in the Turkish rust flora.

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A new species of *Pseudobaeospora* from California

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Abstract – *Pseudobaeospora stevensii* sp. nov. is described from cypress and redwood forests in northern California. Diagnostic features include dark brown basidiomes lacking violet colors, conspicuous cheilocystidia, clamp connections, and tissues that turn olive to grass green or bluish green in alkaline solution. Notes on type studies of several temperate North American species referable to *Pseudobaeospora* are provided.

Key words – agarics, Basidiomycetes, taxonomy

Introduction

The genus *Pseudobaeospora* was established by Singer (1942, 1963) to accommodate *Baeospora oligophylla* Singer, a small, violet species described from the Altai Mountains of central Asia (Singer 1938). Since then, numerous species have been described in or transferred to *Pseudobaeospora*. The generic circumscription was redefined recently by Bas (2002, 2003), wherein he provided a key, full descriptions and illustrations of all known European species. Very few species attributable to *Pseudobaeospora* have been described or reported from temperate North America, and a critical study of North American taxa has not been published. It should be noted that all reported North American *Pseudobaeospora* form violet-colored basidiomes that do not discolor (red, green, blue or yellow-green) in KOH solution.

Recently, an undescribed species with basidiomes that lack violet or purple colors and that turn olive to grass green or bluish green in KOH solution was discovered in northern California, USA. The new species is associated with Monterey cypress (*Cupressus macrocarpa* Hartw. ex Gord.) and redwood (*Sequoia sempervirens* (D. Don) Endl.), two tree species endemic to coastal California. The species is described below and compared with phenetically similar taxa. Color terms and notations are from Kornerup and Wanscher (1978). Spore statistics include: x, the arithmetic mean of the spore length by spore width (± SD) for n spores measured; Q, the quotient of spore length and spore width in any one spore, indicated as a range of variation in n spores measured; Q_m, the mean of Q values.

Pseudobaeospora stevensii Desjardin sp. nov. Figures 1-7

> *Pileus 4-20(-26) mm latus, obtuse conicus vel campanulatus, siccus, glabrus vel subrugosus, brunneus vel obscure castaneus, 3% KOH ope azureo-viridis. Lamellae subliberae, angustae, brunneae vel pallide aurantiobrunneae. Stipes 20-35 X 1-3 mm, cylindricus, siccus, apicaliter ex furfuraceo scabrosus, basin versus squamulis brunneis vel aurantiogriseis instructus, basaliter albidulostrigosus. Colores violacei desunt. Basidiosporae 3.2-4 X 2.8-3.2 µm, ovoideae, subglobosae vel late ellipsoideae, leves, hyalinae vel pallide stramineae (in aqua), forte dextrinoideae, haud metachromaticae, membrana subincrassata instructae. Basidia 4 spora. Cheilocystidia 27-38 X 3.5-8 µm, cylindrica vel clavata, hyalina, tenuitunicata. Pleurocystidia nulla. Pileipellis ex hyphis cylindricis appressisque, 3-8(-10) µm diam. cutem formantibus, haud gelatinosis, membrana dextrinoidea, hyalina vel brunnea (pigmento intraparietali vel incrustato) instructis. Hypodermium subcellulare, haud gelatinosum. Caulocystidia 40-80 X 4-7 µm, cylindrica vel clavata. Fibulae praesentes. Caro 3% KOH ope olivacea vel azureo-viridis. Ad frustula dejecta sub Cupresso et Sequoiae. USA (California). Holotypus hic designatus: A.W. Wilson #133 (SFSU).*
>
> ***Etymology***: Named in honor of Fred Stevens who discovered the new species and who has been instrumental in documenting the fleshy fungi of California.

Pileus (Figs. 1-2) 4-20(-26) mm diam, obtusely conical to campanulate, sometimes broadly campanulate at maturity with uplifted margins; margin even to striate or short-sulcate in age; surface dry, glabrous, smooth to wrinkled; when young disc dark brown to dark reddish brown (8-10F5-7) with a slightly paler reddish brown margin (8-9D5-7), in age becoming paler overall to light brown (7D5-6) or retaining a dark brown margin (5-8F8), lacking any violet or lavender tones; drying dark brown (7F5-8) overall; 3% KOH on pileus surface turning bluish green. **Context** 0.5-1 mm thick, pallid. Odor fungal. Taste slightly acrid and peppery. **Lamellae** subfree, close with 3-4 series of lamellulae, broad (3-4.5 mm), convex to ventricose, brownish orange (7C5) to brown (7D4-5), lacking violet or lavender tones; drying brown (7D-E5). **Stipe** 20-35 X 1-3 mm, central, cylindrical, fistulose, dry, apex furfuraceous to scabrous, squamulose elsewhere, base covered with long, strigose, off-white to pale orangish white (5-6A-B2) hairs; apex brown (7E7-8), base dark brown (7F7-8), with greyish orange (6B3) to pale brownish grey (6C3) squamules.

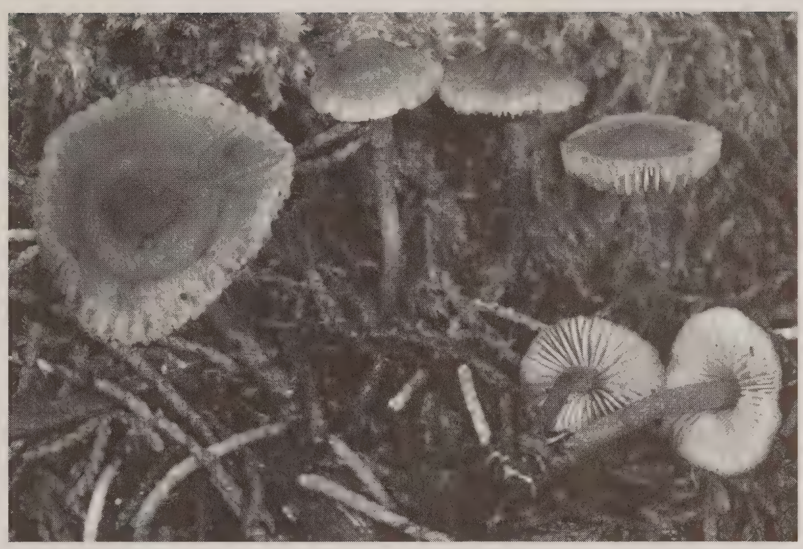
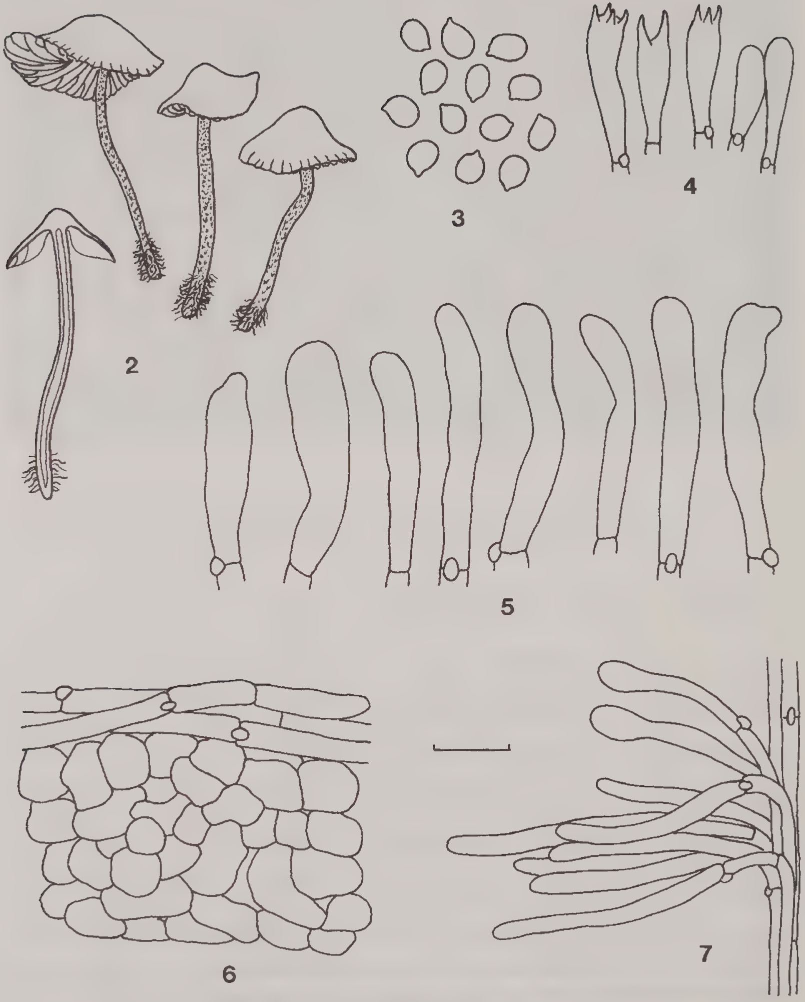


FIG. 1. Basidiomes of *Pseudobaeospora stevensii* (AWW 133– Holotype). Scale: Twice natural size. A color photograph of this specimen may be viewed at www.mykoweb.com.

Basidiospores (Fig. 3) 3.2-4 X 2.8-3.2 μm [x = 3.45 ± 0.26 X 3.0 ± 0.1 μm, Q = 1.1-1.3, Q_m = 1.14 ± 0.08, n = 25 spores), ovoid to subglobose or broadly ellipsoid with an eccentric hilar appendage, smooth, hyaline to pale yellow in H_20, strongly dextrinoid, non-metachromatic, with relatively thick walls. **Basidia** (Fig. 4) 16-20 X 4.5-5 μm, clavate, 4-spored, rarely 2-spored, clamped. **Basidioles** (Fig. 4) clavate. **Cheilocystidia** (Fig. 5) common, lamellar edge sterile or heteromorphous with clusters of cheilocystidia, 27-38 X 3.5-8 μm, cylindrical to narrowly clavate or irregular in outline, hyaline, thin-walled, greenish in 3% KOH. **Pleurocystidia** absent. **Pileipellis** (Fig. 6) two-layered: suprapellis a thin (up to 30 μm thick) cutis of appressed, radially arranged, cylindrical hyphae 3-8(-10) μm diam, with repent to erect, cylindrical to clavate or fusoid terminal cells; walls non-gelatinous, dextrinoid, hyaline to brown in H_2O and 3% KOH; pigment intraparietal and incrusting; suprapellis overlaying a well-developed subpellis. **Subpellis** (Fig. 6) composed of inflated to irregular or puzzle-like hyphae (subcellular) 6-24 μm diam, forming a layer up to 100 μm thick; hyphae non-gelatinous, dextrinoid, hyaline to pale yellowish brown in H_2O, olive to grass green or bluish green in 3% KOH, pigment intraparietal. **Pileus trama** of interwoven, elongated, cylindrical hyphae 2.5-6 μm diam, non-gelatinous, weakly dextrinoid, hyaline to yellow in H_2O, vaguely green in 3% KOH.



FIGS. 2-7. *Pseudobaeospora stevensii* (AWW 133– Holotype). 2. Basidiomes. 3. Basidiospores. 4. Basidia and basidioles. 5. Cheilocystidia. 6. Pileipellis and hypodermium. 7. Caulocystidia. Scale bar: 2 = 10 mm; 3-5 = 10 μm; 6-7 = 20 μm.

Hymenophoral trama regular; hyphae 3-9 µm diam, similar to those in pileus trama. **Stipe tissues** monomitic. **Stipitipellis** a cutis of repent hyphae with clusters of erect caulocystidia; cortical hyphae 2.5-4 µm diam, non-gelatinous, dextrinoid, hyaline to pale brown in H_2O, olive to green in 3% KOH; medullary hyphae 2.5-10 µm diam, similar to cortical hyphae. **Caulocystidia** (Fig. 7) common, 40-80 X 4-7 µm, cylindrical to narrowly clavate, similar to the cheilocystidia, hyaline, thin-walled. **Clamp connections** present in all tissues.

Habit, habitat and distribution – Scattered to gregarious in leaf litter under Monterey cypress (*Cupressus macrocarpa*) or rarely under redwood (*Sequoia sempervirens*). Aug.-Dec. California.

SPECIMENS EXAMINED – UNITED STATES. CALIFORNIA: Marin Co., Audubon Canyon Ranch, Galloway Canyon, 11 Dec. 1979, *C. Calhoun 79-1255*. San Mateo Co., San Bruno, Skyline College campus, 1 Sept. 2001, coll. by F. Stevens, *AWW 133* (Holotype); same location, 26 Aug. 2001, *Stevens 8-26-01*; same location, 10 Sept. 2001, *Stevens 9-10-01*. All specimens deposited in SFSU.

Commentary – *Pseudobaeospora stevensii* is characterized by basidiomes that are dark brown overall (lacking any violet, lilac or lavender colors), and have very small, dextrinoid basidiospores, a two-layered pileipellis (with filamentous suprapellis and subcellular subpellis), 4-spored basidia, conspicuous narrowly clavate cheilocystidia and caulocystidia, and abundant clamp connections. It has been collected only in association with cypress and redwood in California. Within the genus *Pseudobaeospora*, the new species is unusual in forming dark brown basidiomes with tissues that turn olive to grass green or bluish green in 3% KOH. This microchemical reaction is reminiscent of that exhibited by a number of *Gymnopus* species allied with *G. alkalivirens* (Singer) Halling (cf. Halling 1979, 1981, 1990), and *Leucoagaricus* species (E. Vellinga, pers. comm.). Bas (2002, 2003) reports five other alkaline-virescent species of *Pseudobaeospora*; *viz.*, *P. dichroa* Bas, *P. pallidifolia* Bas, A. Gennari & Robich, *P. pyrifera* Bas & L.G. Krieglst., *P. jamonii* Bas, Lalli & Lonati, and *P. mutabilis* Adamcík & Bas. The latter five species differ from *P. stevensii* by the following features. *Pseudobaeospora dichroa* differs in forming basidiomes with purplish brown to violet pilei and lamellae, lacks the two-layered pileipellis, and more importantly has a KOH reaction that is initially red, fading to yellowish green in time (Bas 2002, 2003). *Pseudobaeospora pallidifolia* differs in forming violet brown pilei with white to pinkish cream lamellae, larger basidiospores (4.5-6 X 3-4.5 µm), lacks cheilocystidia and lacks the two-layered pileipellis (Bas et al. 1997; Bas 2003). *Pseudobaeospora pyrifera* differs in forming dark purplish to vinaceous brown or pinkish brown pilei, reddish violaceous lamellae, a dark reddish brown stipe, has broader cheilocystidia (up to 13 µm diam.), and also lacks the two-layered pileipellis (Bas and Krieglsteiner 1998; Bas 2003). *Pseudobaeospora jamonii*, shares with *P. stevensii* the two-layered pileipellis, narrowly clavate cheilocystidia and small basidiospores, but differs significantly in forming greyish purple to violaceous brown pilei, lilac to yellowish grey lamellae, a lilac to purplish brown stipe, has a paler green KOH reaction, and is associated with *Alnus*, *Fraxinus*, *Fagus*, *Corylus* and *Picea* (Bas et al. 2002; Bas 2003). *Pseudobaeospora jamonii* is known at present only from northwestern and central Italy. *Pseudobaeospora mutabilis* differs in forming dark violaceous grey-brown pilei with pinkish grey margins, violet lamellae, broadly clavate cheilocystidia 7-11(-18) μm in diam., and a hymeniform pileipellis of erect chains of inflated cells. The latter species is associated with *Molinia*, *Frangula* and *Betula* and is known at present only from the type locality in Slovakia (Adamcík and Bas 2002; Bas 2003).

Notes on North American *Pseudobaeospora* – Few species of *Pseudobaeospora* have been reported from temperate North America. Coker (1929) reported *Prunulus syringeus* Murrill from North Carolina. It was described originally from Jamaica, and is now known as *Pseudobaeospora murrillii* E. Horak (1964; a new name, non *Pseudobaeospora syringea* Singer). Smith (1947) mentioned this species (as *Mycena syringea* (Murrill) Murrill) and suggested that it was similar to *Tricholoma microsporum* Ellis, which he collected in Michigan, New York, Ontario and California. Although Smith studied the type specimen of *Pr. syringeus* (NY), the holotype packet is now empty so I was unable to obtain any microscopic data (pers. obs.). I have collected numerous specimens of what Coker (1929) called *Pr. syringeus* from North Carolina, Tennessee and other areas in the Appalachian Mts., and the latter species forms deep violet basidiomes with abundant clamp connections, no cheilocystidia, has a cutis-type pileipellis of hyphae 5-12 μm diam, lacks a subcellular hypodermium, and does not discolor in KOH. Whether this is the same species as that from Jamaica cannot be determined at present. The type of *Tricholoma microsporum* was distributed as part of the Ellis and Everhart, North American Fungi Exsiccata, as #2003, from Newfield, New Jersey. I have studied several representative specimens (K, NY, SFSU) and this species forms violet basidiomes with a thin cutis-type pileipellis that overlays a subcellular hypodermium, has dextrinoid basidiospores 4-5 X 3.5-4.5 μm, lacks cheilocystidia, lacks clamp connections, and does not discolor in KOH. Clearly, it is distinct from *Pr. syringeus* sensu Coker.

Agaricus fuscolilacinus Peck (1886) was described from the Adirondack Mts. of New York, and was reported to form watery-brown to lilac-brown, glabrous pilei, close, adnexed, brownish lamellae, and a brown stipe with pruinose apex and white, villose hairs at the base. An analysis of the holotype specimen (NYS!) revealed the following features: *Basidiospores* 4.2-6.8 X 3.2-4 μm [$x = 5.2 \pm 0.6$ X 3.5 ± 0.2 μm, Q = 1.2-2, $Q_m = 1.5 \pm 0.2$, n = 30], ellipsoid to lacrymoid, thick-walled, smooth, inamyloid to weakly dextrinoid. *Basidia* 16-20 X 4-5 μm, 2-spored. *Cheilocystidia* absent. *Pileipellis* a hymeniform layer of broadly clavate cells 12-26 X 7-14 μm, sometimes in chains, thin-walled, subhyaline to pale ochraceous in KOH, inamyloid. *Tramal hyphae* 4-12 μm diam, hyaline, inamyloid, thin-walled, non-gelatinous. *Stipe vesture* a tangled layer of hyaline to pale yellow hyphae 2-5 μm diam, cylindrical, inamyloid, with a few erect, cylindrical to vesiculose caulocystidia. *Clamp connections* present. This species belongs in *Pseudobaeospora* where it is allied with *P. mutabilis*. A formal transfer will not be made until more specimens from the Adirondack Mts. referable to *A. fuscolilacinus* are collected for comparison. The latter species differs from *P. stevensii* in forming larger basidiospores on 2-spored basidia, in lacking cheilocystidia, and in lacking a two-layered pileipellis.

Pseudobaeospora pillodii (Quél.) Wasser was reported from British Columbia, Canada by Redhead (1982). Bas (2003) suggested that Redhead's material may represent *P. oligophylla* (Singer) Singer, a species accepted by Redhead as a synonym of *P. pillodii*. These two taxa differ only subtly in pileipellis anatomy. Nonetheless, both taxa are quite distinct from *P. stevensii* in forming lilac to purple basidiomes that lack cheilocystidia, lack clamp connections, and do not discolor to green in KOH.

Acknowledgments

I would like to thank Dr. Fred Stevens for bringing this new species to my attention and for all of his fine contributions to mycology in California. I thank Andrew Wilson for taking notes on fresh material of the holotype specimen, Dr. Egon Horak for correcting the Latin diagnosis, and Dr. Else Vellinga and Brian Perry for reviewing the manuscript and for providing helpful comments and obscure literature.

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Les pycnides et conidies de *Lecanora vaenskaei* (lichens, *Lecanoraceae*)

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Résumé—La découverte de pycnides sur un spécimen de *Lecanora vaenskaei* permet de compléter la description de cette espèce et de confirmer sa position systématique. Elle est comparée avec les espèces voisines, plus particulièrement *L. achariana.*

Abstract— Discovery of pycnidia on a specimen of *Lecanora vaenskaei* confirms its systematic position. The species description is emended, and the species is compared to related species, especially *L. achariana.*

Resumo—La malkovro de piknidioj en specimeno de *Lecanora vaenskaei* ebligas kompletigi la priskribon de tiu–chi specio kaj konfirmi ties sistematikan lokon. Komparo kun la parencaj specioj, pli speciale *L. achariana.*

Introduction

Lecanora vaenskaei Cl. Roux et Clother Coste, décrit par Roux et al. (1993), est un *Lecanora* saxicole-calcifuge du sud-est méditerranéen français caractérisé par un thalle épilithique vert-jaune clair, formé de granules se transformant en petites squamules ombiliquées courtement lobées, à cortex supérieur et cortex inférieur, et contenant de l'acide usnique et de la zéorine. Les apothécies qui se forment à l'extrémité des lobes des squamules sont typiquement lécanorines et nettement resserrées à la base ou même courtement pédonculées. Par la structure de ses apothécies, *Lecanora vaenskaei* appartient bien aux Lecanoraceae, tout comme des espèces voisines (*L. chaffiniana* Houmeau et Cl. Roux, *L. chlorophaeodes* Nyl., *L. weberi* Ryan) et les *Rhizoplaca* (Roux et al. 1993).

Quoique très détaillée et richement illustrée, la description originale de *L. vaenskaei* est incomplète, puisque ses auteurs n'avaient pas observé de pycnides. Or, en réexaminant un spécimen (Roux n° 21429), j'ai eu la chance d'y découvrir quelques pycnides typiques, riches en conidies, dont l'observation microscopique a permis de compléter la description de l'espèce et de confirmer sa position systématique. Ce spécimen est choisi comme épitype.

Méthodes

Les coupes et préparations microscopiques ont été réalisées à main levée et observées dans l'eau et le bleu coton au lactophénol, avec un microscope photonique (grandissement maximal de × 1500) muni d'un dispositif de contraste interférentiel. Les dessins ont été réalisés avec l'aide d'un tube à dessin. Le seul spécimen disponible étant ancien, les mesures ont été effectuées dans l'eau, sur du matériel mort.

Lecanora vaenskaei Cl. Roux et Clother Coste

in Roux, Coste, Ménard, Bellemère et Bricaud, *Can. J. Bot.*, **71:** 1660-1671 (1993). France, Provence, Var, Le Muy, la Roquette, 500 mà l'ouest de la chapelle ruinée, sur une surface rocheuse de brêche non calcaire, périodiquement inondée. Alt. 110 m. 1992/10/29. Holotype MARSSJ; isotypes MARSSJ, GZU, H.
Épitype: France, Provence, Var, Roquebrune-sur-Argens, rocher de Roquebrune, partie E, près du chemin, sur une surface rocheuse de brêche non calcaire. Alt. 60 m. 1992/05/21. MARSSJ, Herbier C. Roux n°21429.

Pycnides complètement enfoncées dans le thalle (situées dans la couche algale), entièrement incolores, subglobuleuses, d'environ 0,25–0,3 × 0,2–0,25 mm, simples (uniloculaires). Les coupes ne passant pas par l'ostiole celui–ci n'a pu être observé, mais il n'est pas saillant puisque non visible au stéréomicroscope. La pycnide (fig. 1) est délimitée par une mince paroi incolore de 5–10 μm d'épaisseur, formée de deux couches de cellules globuleuses ou subglobuleuses de 3,5–5,5 × 2,5–4,5 μm de diamètre (lumière de 1–2,5 × 1–2 μm), à paroi épaisse (de 1–2 μm). **Conidiophores** simples ou ramifiés, à cellules de 3–10,5 × 2–3 μm (lumière de 2–9,5 × 1–2 μm, paroi d'environ 0,5 μm d'épaisseur), de type exobasidié (portant la ou les cellules conidiogènes à leur ou leurs extrémités distales). **Cellules conidiogènes** (fig. 1 et 2) longuement ampulliformes, de 6,5–11 × 2,5–3,5 μm (lumière de 5–9,5 × 1–2 μm, paroi de 0,5–1 μm d'épaisseur). **Conidies** (fig. 3) filiformes, modérément courbes, de (16)18–31 × 1 μm (d'après 16 mesures).

Discussion

L'étude de la morphologie et de la structure des pycnides et des conidies de *L. vaenskaei* confirme la parenté de cette espèce avec les *Lecanora* à thalle squamuleux ou placodiomorphe jaune verdâtre à acide usnique, en particulier *L. achariana* A. L. Sm., *L. chaffiniana, L. chlorophaeodes* et *L. dispersoareolata* (Schaer.) Lamy. Dans ce groupe d'espèces, *L. chlorophaeodes* et *L. dispersoareolata* s'éloignent le plus de *L. vaenskaei* par l'absence de cortex inférieur même rudimentaire, tandis que *L. chaffiniana* a une ébauche de cortex (Houmeau et Roux 1988) pigmentée de vert noirâtre et *L. achariana,* tout comme *L. vaenskaei*, un cortex inférieur non pigmenté ou pigmenté de brun rouge ou de rose au contact du support, cortex déjà observé par Harmand

(1913: 926). *L. chaffiniana* se distingue également de *L. achariana* et de *L. vaenskaei* par la présence d'acide gyrophorique et l'absence de zéorine.

Bien que Roux et al. (1993) n'aient pas comparé *L. vaenskaei* avec *L. achariana,* c'est pourtant cette espèce qui a le plus d'affinités avec *L. vaenskaei*, notamment par la structure du thalle, la morphologie et la structure des apothécies, par des conidies (Harmand 1913: 927) d'environ 30 *x* 1 *µ*m et par son écologie (sur des surfaces d'écoulements temporaires). *L. vaenskaei* s'en distingue néanmoins (tableau 1) par un thalle nettement plus adhérent au substrat, d'aspect plus granuleux que squamuleux, à lobes beaucoup plus petits, des apothécies terminales, des spores plus larges et l'absence de triterpénoïdes.

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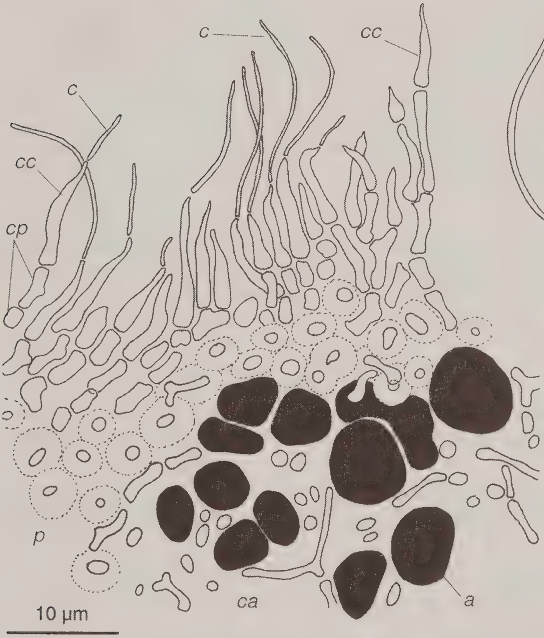

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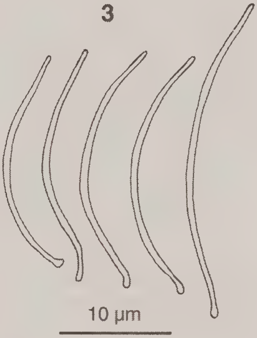

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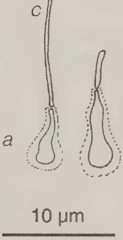

Fig. 1. Structure microscopique de la partie basale d'une pycnide de *Lecanora vaenskaei* d'après une coupe radiale observée dans le bleu coton au lactophénol. *a:* cellule algale; *c:* conidie; *ca:* couche algale (hyphes et cellules algales); *cc:* cellule conidiogène ; *cp*: conidiophore; *p*: paroi de la pycnide formée de deux couches de cellules à paroi épaisse.

Fig. 2. Cellules conidiogènes de *Lecanora vaenskaei,* portant une conidie immature, observées dans le bleu coton au lactophénol. *a:* cellule conidiogène; *c:* conidie.

Fig. 3. Conidies matures de *Lecanora vaenskaei,* observées dans l'eau.

Tableau 1. Caractères distinctifs de *Lecanora vaenskaei* et *L. achariana*

	Lecanora vaenskaei	*Lecanora achariana*
Thalle	nettement adhérent au support, d'aspect plus granuleux que squamuleux, formé de granules ou de petites squamules à lobes de 0,3–0,5 × 0,15–0,3 mm	peu adhérent au support, d'aspect nettement squamuleux, formé de squamules à lobes de 1,5 × 0,5-2 mm
Spores	(9)10-14(17) × 4(4)6-8(9)10 μm	10-15(16) × 4-6 μm
Apothécies	terminales	subterminales
Chimisme	acide usnique, zéorine (Roux et al. 1993)	acide, usnique, zéorine, triterpénoides (Purvis et al. 1992)
Répartition et écologie	région méditerranéenne; étage mésomméditerranéen; thermophile	montagnes d'Europe centrale et septentrionale, de Corse et de Sardaigne; étage montagnard; non thermophile

Spécimen de *Lecanora achariana* examiné: France, Haute-Corse, forêt d'Aïtone, près du foyer de ski de fond, sur une surface subhorizontale de granite très cohérent, soumise à de brefs écoulements périodiques. Alt. 1100 m. 1999/04/19. MARSSJ, Herbier C. Roux (sans numéro).

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New and previously unrecorded saxicolous species of *Buellia* s.l. with one-septate ascospores from the Greater Sonoran Desert Region

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Abstract—The following species of *Buellia* s.l. from the Greater Sonoran Desert Region are described new to science: *Buellia nashii*, *B. navajoensis*, *B. regineae* and *B. sheardii*. A valid description is provided for *B. lepidastroidea*, a name introduced by Imshaug, but never validly published. *Buellia argillicola* is reported from the Sonoran Region for the first time. A single record of the rare and unusual *B. vilis* is reported from Arizona. *Buellia novomexicana* and *B. fusca* are synonymized with *B. tyrolensis*. Detailed descriptions are provided for all these species. In addition a dichotomous key includes all saxicolous species with one-septate ascospores currently known from the Greater Sonoran Desert Region.

Zusammenfassung–Die folgenden neuen Arten der Sammelgattung *Buellia* s.l. werden aus der Sonoraregion beschrieben: *Buellia nashii*, *B. navajoensis*, *B. regineae* and *B. sheardii*. Eine weitere Art ist *Buellia lepidastroidea*. Diese Art wurde bereits von Imshaug vorgeschlagen, aber nicht gültig publiziert. Sie wird hier erstmals mit einer gültigen Artdiagnose versehen. *Buellia argillicola* wird erstmals aus der Sonoraregion nachgewiesen. Ein Einzelfund der seltenen und ungewöhnlichen Art *B. vilis* wird aus Arizona gemeldet. *Buellia novomexicana* und *B. fusca* werden mit *B. tyrolensis* synonymisiert. Alle diese Arten sind hier detailliert beschrieben. Darüber hinaus ermöglicht ein dichotomer Schlüssel die Bestimmung aller bisher aus der Region bekannten, saxikolen Arten mit zweizelligen Sporen.

Key Words—taxonomy, lichenized ascomycetes, *Physciaceae*, new species, dichotomous key

Introduction

A revision of the saxicolous species of *Buellia* s.l. with one-septate ascospores from the Greater Sonoran Desert Region currently accepts a total of thirty-one species. Several of these species have never been reported from the area or are not yet described. Descriptions of these new species and records are given here. A complete treatment of the genus will be included in the third volume of the Sonoran Desert Lichen Flora (Nash et al. 2002) but a key to all species is published here to allow identification of all species currently known from this region.

The species described here are not necessarily members of what might be considered the core group of *Buellia* De Not. (Bungartz & Nash 2004c). Traditionally specimens, which are related to *Buellia aethalea* (Ach.) Th. Fr. have been associated with *Buellia* s.str. but the current Botanical Code (Greuter et al. 2000) lists *Buellia disciformis* (Fr.) Mudd, a species with distinct characters of *Hafellia* Kalb, H. Mayrhofer & Scheid., as the type. There is currently some discussion to change this typification, but a proposal by Moberg et al. (1999) is not presently accepted. Until the outcome of this proposal is decided, a broad concept of *Buellia* s.l. is therefore adopted. Taxonomic affinities of the species described, are discussed in more detail within brief notes for each species. The genus concept of *Buellia* is currently in a state of much disarray (Eriksson et al. 2002, Nordin 2000) and the question, which genera will ultimately be recognized should best be addressed using molecular tools to evaluate classical data.

Methods

All specimens were examined with light microscopy using hand- and cryosections. Both conventional bright field microscopy (BF) as well as differential interference contrast (DIC) were used. Selected specimens were also studied with transmission electron microscopy (TEM) according to a protocol described in detail by Bungartz et al. (2002). To improve dehydration and infiltration this protocol has been modified according to Bungartz & Nash (2004a).

All specimens were spot tested and routinely examined with standardized thin-layer chromatography (Culberson & Johnson 1982, Culberson & Kristinsson 1970, Orange et al. 2001, White & James 1985). TLC-Plates were interpreted with the computer program WINTABOLITES (Mietzsch et al. 1994), and scanned for permanent record Egan (2001). In addition a subset of specimens was analyzed by Dr. Jack A. Elix from the Australian National University in Canberra using standardized High Performance Liquid Chromatography (HPLC, Feige et al. 1993). Spores measurements are given according to Nordin (2000). Pigment names follow Meyer & Printzen (2000). Detailed specimen information about all collections deposited at ASU is available at: http//seinet.asu.edu/collections/selection.jsp.

Taxonomic Descriptions

Buellia argillicola de Lesd., Ann. Cryptog. Exot. II: 243 (1929) FIGURE 1

Type: MEXICO. México. San Jerónimo. On volcanic rocks (pebbles embedded in soil) [original label data: Estado de Distrito Federal. San Jerónimo, Sobre Piedra], 19°13’30”N, 100°01’30”W, 2598 m alt., Pedro (Pierre) Lyonett *no. 110* (MEXU! – neotype selected here).

Taxonomic note: No type material from the original collections was found. It can be assumed that de Lesdain’s holotype collection, originally located in Dunkerque (France), has been destroyed during the Second World War. The specimen selected as a neotype was collected at the type locality and agrees well with the description in the protologue.

THALLUS (Fig. 1A, B)—Crustose, thin, usually growing in distinct circular patches, subeffigurate, several thalli often confluent, epilithic; continuous to rimose with fine fissures; prothallus distinct, delimiting the thallus as a black outline; thallus surface matt and chalky, dull, usually white, rarely gray, heavily pruinose, phenocorticate; entire thallus filled with an abundance of calcium oxalate (H_2SO_4+ forming clusters of needle shaped crystals).

APOTHECIA—Lecideine, (0.3–)0.5–0.8(–1.1) mm in diameter, remaining immersed

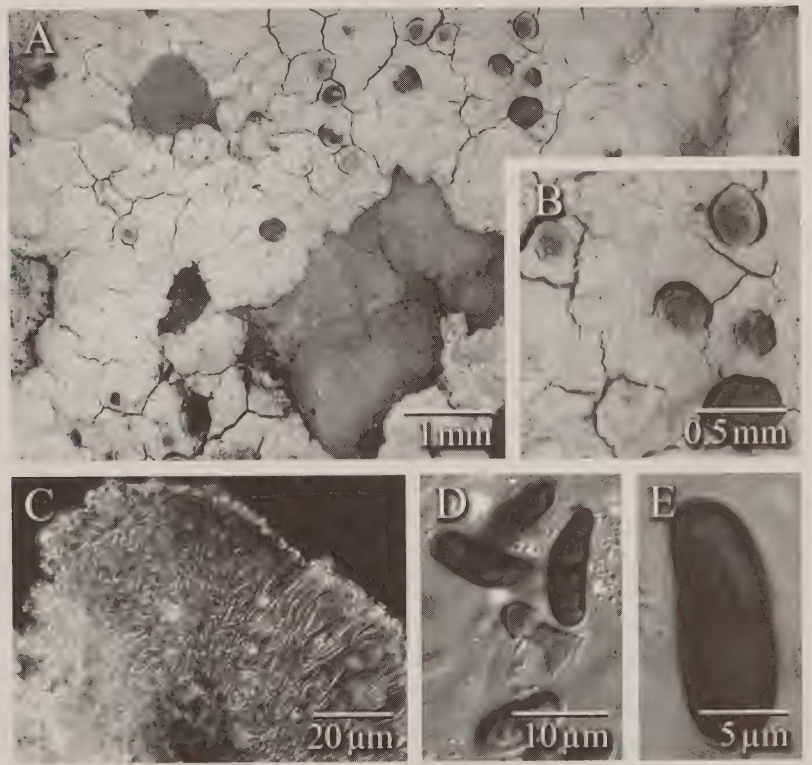

Fig. 1: Light micrographs of *Buellia argillicola* (Nash *12152*). – A. Overview of the rimose thallus. – B. Close-up of the rimose thallus and apothecia. – C. Cross section of the *aethalea*-type exciple. – D. Oblong, ascospores. – E. Ascospore: no septum thickening is present during the spore ontogeny.

to indistinctly adnate; proper margin thick, persistent, not excluded with age, black, usually covered with a dense, fine, white pruina; disc black, plane, not becoming convex with age, usually covered with a dense, fine, white pruina; proper exciple similar to the *aethalea*-type (**Fig. 1C**) *sensu* Scheidegger (1993), i.e. inner exciple almost entirely reduced, hyphae narrow, hyaline, prosoplectenchymatous (*textura oblita*), similar in structure and orientation to the paraphyses, transient with the deep reddish brown hypothecium (*leptoclinoides-brown*, *textura intricata*), outer exciple expanded, globular cells strongly swollen (± *textura oblita*) and moderately carbonized with a brown pigment (cf. *elachista*-brown), pigmentation continuous with the epihymenium; hymenium hyaline, not inspersed; paraphyses simple to moderately branched, apically swollen, with a brown (cf. *elachista*-brown) pigment cap.

ASCI—8-spored, clavate, *Bacidia*-type. **ASCOSPORES** (**Fig. 1D, E**)—oblong to ellipsoid, usually not constricted, with obtuse ends, not curved, (12.0–)15.0–[16.8]–18.5(–20.0) x (6.0–)6.5–[7.3]–8.1(–9.0) μm ($n = 60$), one-septate, proper septum narrow, not thickening during spore ontogeny, lateral wall thickenings absent [*Beltraminea* (=*Buellia*)-type]; ornamentation rugulate.

PYCNIDIA—Rare, urceolate to globose, unilocular, at maturity almost entirely occupied by densely branched conidiophores; conidiogeneous cells mostly terminal, rarely also intercalary (cf. conidiophore-type V *sensu* Vobis 1980); pycnidial ontogeny similar to the *Umbilicaria*-type (sensu Vobis 1980 and Vobis & Hawksworth 1981); conidia simple, bacilliform, 4.0–6.5 x 1.0–1.5 μm ($n = 20$).

CHEMISTRY—With the depsidones norstictic, connorstictic, stictic and hypostictic acid and one unknown substance (RF 7, not visible in natural light, UV+ orange). Thallus and medulla K+ faint yellow (yellow solution, but not orange, needle-shaped crystals observed in the microscope), P+ faint yellow, C–, KC–, CK–. UV+ pale white. Thallus and apothecia react amyloid with Lugol's (always test with concentrated Lugol's iodine or in the compound microscope; positive reactions can be very weak!).

SUBSTRATE AND ECOLOGY—The type specimen grows on pebbles embedded in calcareous (HCl+) soil (= *tépetate*), the only known Sonoran specimens grow on limestone (strongly HCl+).

DISTRIBUTION (Fig. 3)—Rare, in the Sonoran Desert only known from a single location, originally described from central Mexico.

NOTES—Specimens of *B. argillicola* are superficially similar to *B. subalbula* (Nyl.) Müll. Arg. or *B. venusta* (Körb.) Lettau. The thalli of *B. argillicola* are, however, more continuous and less extensively fissured. Apothecia of *B. argillicola* have a plane disc with a persistent lecideine margin and no thalline collar or veil. Internally the structure resembles the *aethalea*-type but the outer exciple is much more prominent and persistent. Both *B. subalbula* and *B. venusta* have a thin, largely reduced exciple, which usually becomes excluded by the swelling of the disc. In *B. venusta* a thalline collar is common and it can sometimes be present in *B. subalbula*. *Buellia subalbula* is restricted to the coast whereas *B. argillicola* is known from inland localities. *Buellia subalbula* is characterized by a fuscous brown to deeply aeruginose exciple, which always reacts HNO_3+ violet. *Buellia venusta* and *B. argillicola* have no aeruginose exciple pigment. *Buellia venusta* has pluriseptate, *B. argillicola* one-septate ascospores.

REPRESENTATIVE SPECIMEN EXAMINED—MEXICO. **Sinaloa.** Nash *12152* (ASU).

Buellia lepidastroidea Imshaug *ex* Bungartz sp. nov. **FIGURE 2**

Thallus saxicolus, crustaceus, areolatus vel bullato-areolatus, crassus, eburneus, cum hypothallo atero. Apothecia sessilia, lecideina, marginibus propriis exclusis. Excipulum tenuis, fulvum, sine pigmento aeruginoso, carbonaceum. Hymenium interspersum guttae olei. Asci 8-spori. Sporae uniseptae, oblongae vel ellipsoideae, septibus incrassatus, 7–17 x 5-8 µm. Pycnidia urceolata vel globosa. Conidia bacilliformes, 2-7 x 1-2 µm. Thallus atranorina, ± diploicina et ± fulgidina continens. Medulla non- amyloideus.

Type: MEXICO. Baja California. Isla Cedros, ridge crest overlooking western shore and adjacent canyon to the E at the NW corner of the island, 28°22'00"N, 115°15'30"W, ca. 300 m alt., on acidic rock, 19 March 1994, Nash *34458* (ASU! – holotype designated here).

Taxonomic note: The species name was first used by Imshaug (1951) in his dissertation but was never validly published.

THALLUS (Fig. 2A, B)—Crustose, thin to moderately thickened, ± continuous or becoming dispersed, epilithic; areolate to subsquamulose or bullate; prothallus delimiting the thallus margin, distinctly blackened to pale gray, rarely white and indistinct; thallus surface matt and dull, not shiny, usually ivory, rarely beige, epruinose or rarely with a fine pruina, phenocorticate; without Ca-oxalate crystals in the medulla (H_2SO_4–).

APOTHECIA—Lecideine, (0.3–)0.5–0.8(–1.1) mm in diameter, soon sessile; proper margin thin, black, rarely persistent, usually excluded with age; disc black, epruinose, plane, soon becoming convex with age; proper exciple of the *dispersa*-type (**Fig. 2C**) *sensu* Scheidegger (1993), i.e. inner excipular hyphae distinct, not reduced, pigmented, prosoplectenchymatous (*textura oblita*), extending from the deep reddish brown hypothecium (*leptoclinoides*-brown, *textura intricata*); outer excipular hyphae short-celled, cells angular, distinctly swollen (*textura angularis*) and usually ± carbonized with various amounts of brown pigments (cf. *elachista*-brown), pigmentation continuous with the epihymenium; hymenium hyaline, inspersed with oil droplets; paraphyses simple to moderately branched, apically swollen, with a brown pigment cap (cf. *elachista*-brown).

ASCI—8-spored, clavate, *Bacidia*-type (**Fig. 2F**). **ASCOSPORES** (**Fig. 2D, G, H**)—oblong to ellipsoid, usually not constricted, with obtuse ends, not curved, (7.0–) 11.4–[13.2]–15.0(–17.0) x (5.0–)6.0–[6.7]–7.4(–8.0) μm ($n = 60$); one-septate, proper septum briefly thickened but soon becoming reduced during spore ontogeny, lateral wall thickenings absent (± *Physconia*-type); ornamentation absent (not visible in DIC); septum with septal pore canal, simple pore and undifferentiated pore plug; spore wall (**Fig. 2G, H**) differentiated into smooth, thin perispore (0.06–0.07 μm), narrow intermediate layer (< 0.03 μm), thick proper spore wall (0.34–0.54 μm) and moderately thickened endospore (0.12–0.21 μm).

PYCNIDIA—Rare, urceolate to globose, unilocular, at maturity almost entirely occupied by densely branched conidiophores; conidiogeneous cells mostly terminal, rarely also intercalary (cf. conidiophore-type V *sensu* Vobis 1980); pycnidial ontogeny similar to the *Umbilicaria*-type (sensu Vobis 1980 and Vobis & Hawksworth 1981); conidia simple, bacilliform, 2.0–7.0 x 1.0–2.0 μm ($n = 41$).

CHEMISTRY—With the depsides atranorin and chloroatranorin and the depsidones diploicin, 3-dechlorodiploicin, fulgidin and isofulgidin. HPLC–artefacts: haematommic acid, methyl β-orsellinate (HPLC by J. Elix, Canberra). Thallus and medulla K+ yellow, P+ orange, C–, KC–, CK–. UV+ pale ivory. The thallus medulla and cortex does not react amyloid, apothecia are amyloid in Lugol's (always test with concentrated Lugol's iodine or in the compound microscope; positive reactions can be very weak!).

SUBSTRATE AND ECOLOGY—On a variety of siliceous (HCl–) rock substrates.

DISTRIBUTION (**Fig. 3**)—Common along the coast of southern California and Baja California.

NOTES—Thalli of *B. lepidastroidea* sometimes vaguely resemble *B. dispersa* or

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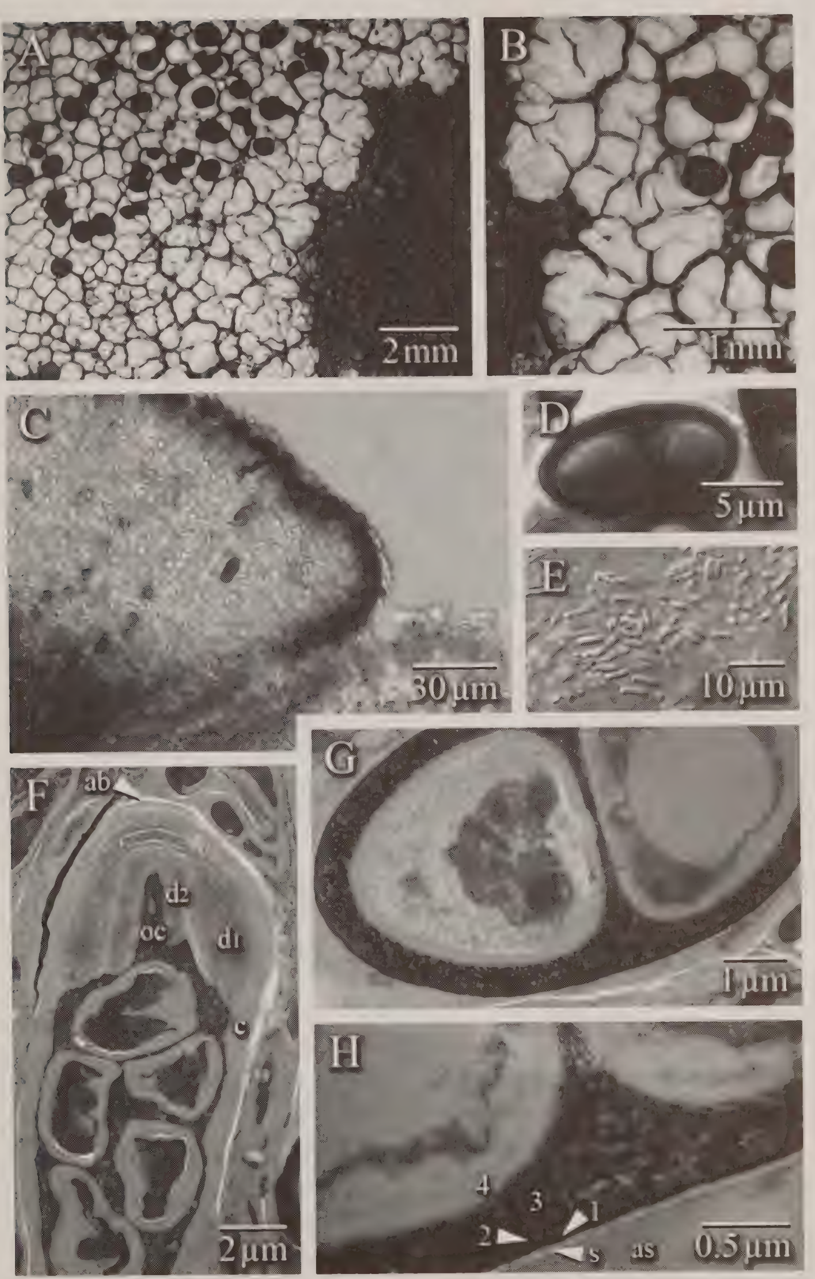
Fig. 2: *Buellia lepidastroidea* (A–E. light micrographs; F–H. TEM micrographs).—A. Overview of the areolate, sublobate thallus with sessile apothecia (Nash *6742a*).—B. Close-up of thallus and apothecia (Nash *6742a*).—C. Cross section through the apothecium with inspersed hymenium (Nash *34458*).—D. Premature ascospore with distinct septal thickening (Nash *34458*).—E. Conidia (Nash *34458*).—F. *Bacidia*-type ascus (Nash *38438*; for designation of the different layers see Bellemère 1994): The a- and b-layer (ab) are barely visible and cannot reliably be distinguished (possibly as a result of fixation artifacts); (c) outer electron opaque c-layer; (d1) d1-layer, i.e. the outer tholus, which is distinctly laminated (in light microscopy this outer part stains deep blue with Lugol's iodine); (d2) d2-layer, i.e. the inner tholus, which is not layered and ± homogeneous (not staining in Lugol's iodine); (oc) ocular chamber .—G. Mature ascospore with reduced septal thickenings (Nash *38438*).—H. Spore wall of a mature ascospore (Nash *38438*): (as) ascus wall; (s) mucilaginous sheath; (1) perispore; (2) intermediate layer; (3) proper spore wall; (4) endospore.


A
2 mm
B
1 mm
C
30 µm
D
5 µm
E
10 µm
F
ab
d2
oc
d1
c
2 µm
G
1 µm
H
4
3
1
2
s
as
0.5 µm

B. nashii. *Buellia lepidastroidea* is, however, strictly coastal and characterized by oil droplets in the hymenium. This inspersion is usually distinct, especially if thick apothecial sections are treated with 5% KOH. In thin sections, oil inspersion may be less conspicuous but nevertheless always present. Thalli growing close to the seashore and subject to spray often show more exuberant growth than sheltered thalli. Their thallus areoles become strongly inflated and apothecia thus appear "stalked".

The North American specimens fit well into the concept of Imshaug's *B. lepidastroidea* and the species is described here to validate the name Imshaug first introduced for this species. The species belongs to a group of taxa with indistinct *Physconia*-type ascospores, a *dispersa*-type exciple and an oil-inspersed hymenium. This group of species is currently not well understood. *Buellia lepidastroidea* is very similar to European material of *B. excelsa* (Leight.) A.L. Smith. Scheidegger (1993) selected a lectotype for *B. excelsa* but the material could not be found at BM. Specimens identified as *B. excelsa* from Scheidegger's private herbarium have a more distinctly brown thallus, contain only atranorin, not diploicin or fulgidin and were collected at high altitude, not close to the seashore. Scheidegger (1993, p. 349) mentions that the species is distributed "in dunes and in mountains". In the Sonoran Desert Region *B. lepidastroidea* is clearly confined to coastal, maritime habitats and has not been found further inland or at high altitudes. Other taxa in the *Buellia excelsa*-group are *B. boergesenii* Imshaug and *B. jorgensis* Zahlbr. (Chile – M-0061335, Spindler *16158*, det. Follmann). *Buellia conspirans* (Nyl.) Vain. is a saxicolous species similar to *B. boergensii* according to Imshaug (1955). It is currently listed in the North American Checklist (Esslinger 1997) as a synonym of *B. curatellae* Malme. *Buellia curatellae* is, however, a corticolous species with distinct lateral spore wall thickenings. It was transferred by Marbach (2000) into the genus *Hafellia*.

Buellia lepidastroidea is treated here as a distinct species, but a more detailed revision of the *Buellia excelsa*-group is necessary to evaluate the taxa currently included in this group. Because of the oil inspersion in the hymenium, species of the *Buellia excelsa*–group show some affinities to the genus "*Hafellia*". The presence of diploicin and related substances in *B. lepidastroidea* is unusual for *Buellia* s.str. but these substances have been reported from "*Hafellia*". Scheidegger (1993) did, however, not include *B. excelsa* within "*Hafellia*" because the ascospores lack lateral wall thickenings and he did not find diploicin in *B. excelsa*.

Buellia lepidastroidea usually can be easily distinguished from *B.* ("*Hafellia*") *regineae* because of its thinner thallus, with smaller, more dispersed areoles, smaller apothecia and ascospores. Lateral wall thickenings are usually present in spores of *B. regineae*,

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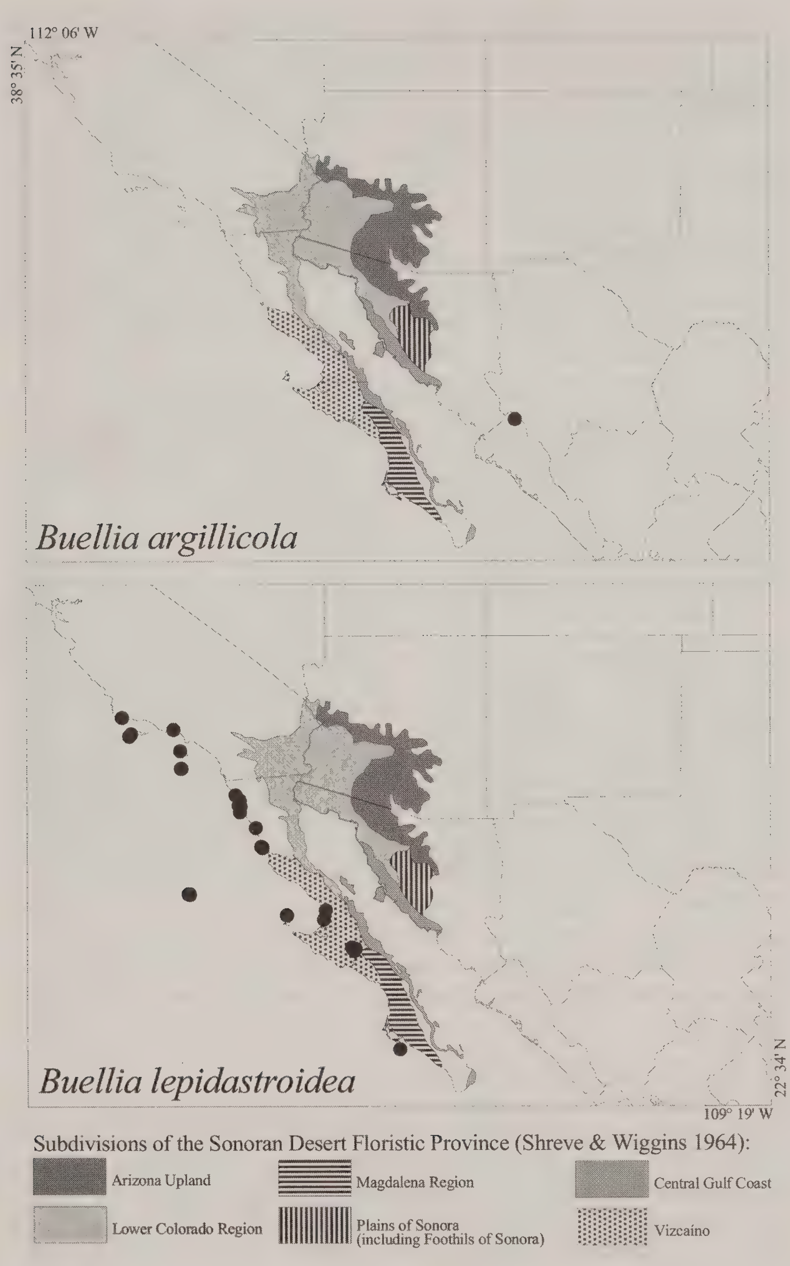
Fig. 3: Distribution of *Buellia argillicola* and *Buellia lepidastroidea* in the Sonoran Desert (Floristic Provinces according to Shreve & Wiggins 1964).


112° 06' W
38° 35' N
Buellia argillicola
Buellia lepidastroidea
22° 34' N
109° 19' W
Arizona Upland
Magdalena Region
Central Gulf Coast
Lower Colorado Region
Plains of Sonora (including Foothils of Sonora)
Vizcaino

Subdivisions of the Sonoran Desert Floristic Province (Shreve & Wiggins 1964):

but less distinct than in *B. leptoclinoides* (see notes on *B. regineae*).

Thalli of *B. lepidastroidea* and *B. excelsa* are very similar to *B. dispersa* and *B. nashii*. All these species also share the same exciple anatomy and have indistinct *Physconia*-type ascospores. The angular thickening of the spore septum, which is characteristic for the *Physconia*-type ascospore, can only very briefly be observed in premature ascospores (Fig. 2D) but becomes soon reduced in mature spores (Fig. 2G & H). *Buellia dispersa* and *B. nashii*, however, do not contain oil droplets within the hymenium.

REPRESENTATIVE SPECIMENS EXAMINED—MEXICO. BAJA CALIFORNIA. Egan *13790* (OMA); Kalb *24657* (hb. Kalb); Scheidegger *Inv. Nr. 170-189*, *71-95*, *150-155* (hb. Scheidegger); Weber *L-43033*, *L-43014*, *L-43062*, *L-36575* (COLO); Wetmore *63852*, *75765*, *72431*, *63498*, *75873* (MIN); Nash *38242*, *34370*, *38241*, *8688b*, *34319*, *4916*, *34052*, *38256*, *8730*, *25188*, *38459*, *34358*, Ryan *2136*, *21263* (ASU). **BAJA CALIFORNIA SUR**. Wetmore *72223* (MIN); Marsh *6080*, Nash *8947* (ASU).**—UNITED STATES. CALIFORNIA. Los Angeles Co.** Bratt *9799*, Bratt *10219*, *11843*, *11844* (SBBG); Hasse *Exs. 155* (ASU); Weber *L-42606*, *L-42823* (COLO). **Santa Barbara Co.** Bratt *7379*, *7605* (SBBG). Nash *32646*, *33021*, Ryan *31255b*, *31270* (ASU). **WASHINGTON. Kittitas Co.** Ryan *16838* (ASU).

Buellia nashii Bungartz sp. nov. FIGURE 4

Similis Buelliae dispersae sed apotheciae cum pigmento aeruginoso et thallus acida norstictica et connorstictica vel acida stictica continens.

Etymology: The species is named in honor of my Ph.D. supervisor Dr. Thomas H. Nash III.

Type: MEXICO. COAHUILA. 3 km W of the paved road, at the Delores sign, 26º00'00"N, 101º00'00"W (estimated coordinates), on volcanic rock, 20 March 1976, Nash *6742a* (ASU! – holotype designated here; one isotype at MEXU, one isotype at US).

THALLUS (Fig. 4A, B)—Crustose, thick, ± continuous or becoming dispersed, epilithic; areolate to subsquamulose; prothallus absent; thallus surface matt and smooth to deeply fissured, dull or ± shiny, usually ivory, beige to deep brown or gray, rarely lead gray, with fine or coarse pruina, rarely epruinose, phenocorticate; with few, or rarely large amounts of Ca oxalate crystals (H_2SO_4+ forming clusters of needle shaped sulphate crystals).

APOTHECIA—Lecideine, (0.4–)0.6–1.1(–1.2) mm in diameter, sessile; proper margin black, thin to thick, usually persistent, rarely excluded with age; disc black, usually epruinose, rarely with white pruina, plane, often becoming strongly convex with age; proper exciple of the *dispersa*-type (**Fig. 4C**) *sensu* Scheidegger (1993), i.e. inner exciple distinct, not reduced, hyphae pigmented, prosoplectenchymatous (*textura oblita*), extending from the deep reddish brown hypothecium (*leptoclinoides*-brown, *textura intricata*); outer excipular hyphae short-celled, cells angular, distinctly swollen

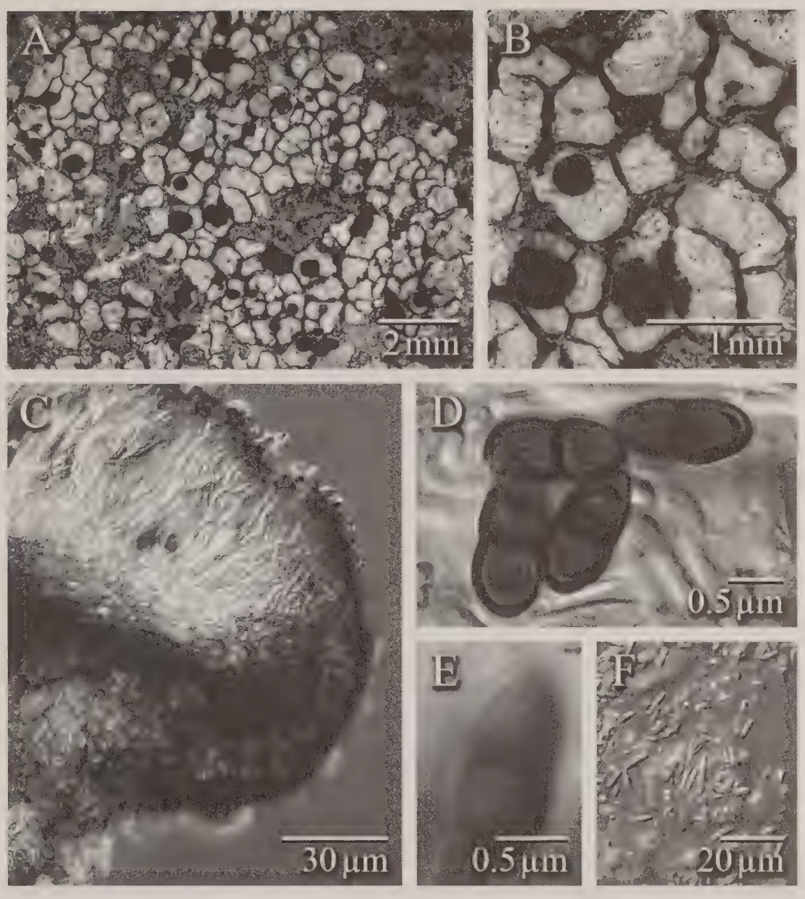


Fig. 4: *Buellia nashii*.—A. Subsquamulose thallus with sessile apothecia (Nash *6724a*).—B. Close-up of thallus (Nash *6724a*).—C. Cross section of an apothecium with *dispersa*-type exciple (Nash *15313b*).—D. Overmature, slightly constricted ascospore with reduced septum thickening (Nash *15313b*).—E. Microrugulate ascospore ornamentation visible at a late stage of the spore ontogeny (Nash *15313b*).—F. Conidia (Nash *15313b*).

(*textura angularis*) and carbonized with various amounts of a brown pigment (cf. *elachista*-brown); small amounts of a diffuse aeruginose pigment present but restricted to the outermost exciple cells (*cinereorufa*-green, HNO_3+ violet); only the brown pigmentation continuous with the epihymenium; hymenium hyaline, not inspersed; paraphyses simple to moderately branched, apically swollen, with a brown pigment cap (cf. *elachista*-brown).

ASCI—8-spored, clavate, *Bacidia*-type. **ASCOSPORES (Fig. 4 D, E)**—oblong to ellipsoid, rarely constricted with age, with obtuse ends, not curved, (11.0–)12.9–[14.5]–16.1(–19.0) x (6.0–)6.5–[7.3]–8.1(–9.0) μm (*n* = 60); one-septate, proper septum briefly thickened but very soon becoming reduced during spore ontogeny, lateral wall thickenings absent (± *Physconia*-type); ornamentation microrugulate.

PYCNIDIA—Rare, urceolate to globose, unilocular, at maturity almost entirely occupied by densely branched conidiophores; conidiogeneous cells mostly terminal, rarely also intercalary (cf. conidiophore-type V *sensu* Vobis 1980); pycnidial ontogeny similar to the *Umbilicaria*-type (sensu Vobis 1980 and Vobis & Hawksworth 1981); conidia (**Fig. 4F**) simple, bacilliform, 5.0–10.0x 1.5–2.0 μm (*n* = 20).

CHEMISTRY—Typically with the depside atranorin and the depsidones norstictic (forming orange, needle-shaped crystals in the compound microscope) and connorstictic acid. Some specimens do not contain norstictic acid but instead are characterized by stictic and hyposititic acid. Specimens typically react K+ yellow to red (sometimes weak), P+ yellow (sometimes weak), C–, KC–, CK–. UV– (pale). The thallus is not amyloid, apothecia react amyloid in Lugol's (always test with concentrated Lugol's iodine or in the compound microscope; positive reactions can be very weak!).

SUBSTRATE AND ECOLOGY—On a variety of siliceous (HCl–) rock substrates, rarely also on sandstones with small amounts of carbonates (HCl+).

DISTRIBUTION (Fig. 6)—The species is widely distributed throughout the Sonoran Desert Region and adjacent areas, extending into NE Mexico, but absent from low desert elevations.

NOTES—Thalli of *B. nashii* are very similar and almost as variable as those of *B. dispersa* (see the description of morphotype I in Bungartz et al. 2002). The two species nevertheless are reliably distinguished by their chemistry (2'-*O*-methylperlatolic acid in *B. dispersa*, *vs.* norstictic and/or stictic acid in *B. nashii*) and their different exciple pigmentation. No specimen with the chemistry of *B. dispersa* contains any traces of the aeruginose, HNO_3+ violet pigment *cinereorufa*-green. In specimens of *B. nashii* this pigment is always present but usually confined only to the outermost cells of the exciple. Specimens should always be tested with HNO_3 for a reliable identification. Most specimens of *B. nashii* contain norstictic acid and are thus easily distinguished form *B. dispersa* because of the formation of distinct orange, needle-shaped crystals if KOH is applied to apothecial or thallus sections.

REPRESENTATIVE SPECIMENS EXAMINED—MEXICO. BAJA CALIFORNIA. Nash *26285*, *26320b* (ASU). **CHIHUAHUA.** Nash *13817*, *13766* (ASU). **COAHUILA.** Nash *6742c* (ASU).—**UNITED STATES. ARIZONA. Cochise Co.** Weber *S8831* (COLO). **Coconino Co.** Boykin *2849*, *2674*, Nash *30677*, *4980* (ASU). **Gila Co.** Nash *7386* (ASU). **Graham Co.** Nash *7661* (ASU). **Maricopa Co.** Nash *8411*, *6266*, *9850*, *6659*, *987*, *5011* (ASU). **Mohave**

Co. Nash *7303* (ASU). **Pinal Co.** Nash *6151* (ASU). **Santa Cruz Co.** Nash *39231* (ASU). **Yavapai Co.** Nash *34137*, *34149*, *34188*, *6361*, Ryan *26958* (ASU). **California**. **Inyo Co.** Ryan *14881* (ASU). **San Diego Co.** Nash *7052* (ASU). **Colorado**. **San Juan Co.** Nash *17757* (ASU). **Nevada**. **Lincoln Co.** Ryan *15862* (ASU). **New Mexico**. **San Juan Co.** Nash *16397*, *16395*, Rankert *117* (ASU). **Utah**. **Kane Co.** Nash *5071*, *5457*, Nash *6610* (ASU). **San Juan Co.** Nebecker *2800* (ASU). **Washington Co.** Nash *15315* (ASU).

Buellia navajoensis Bungartz sp. nov. **FIGURE 5**

Thallus saxicolus, crustaceus, areolatus vel sublobatus, crassus, eburneus, sine hypothallo. Apothecia immersia vel adnatia, lecideina, marginibus propriis tenuis. Excipulum tenuis, fulvo-caeruleum, pigmentum aeruginosum continens, carbonaceum. Asci 8-spori. Sporae uniseptae, oblongae vel anguste oblongae, septibus incrassatus 13–25 x 6-10 µm. Pycnidia urceolata vel globosa. Conidia bacilliformes, 3-4.5 x 1-1.5 µm. Thallus acida norstictica et connorstictica et substancia xanthonia continens. Medulla amyloideus.

Etymology: The species is named after the Native American Navajos and the type specimens were collected on Navajo Sandstone.

Type: U.S.A. Utah. Kane Co. About 16 km east of Kanab along U.S. Highway 89, in Johnson Canyon near the Kanab Stake Welfare Farm, ca. 1734 m, 37°02’14”N, 112°21’53”W, on Navajo Sandstone, Nebecker *1577* (ASU! – holotype designated here).

THALLUS (Fig. 5A, B)—Crustose, thick, ± continuous, epilithic; areolate to sublobate often forming rosettes; prothallus absent; thallus surface matt and dull, not shiny, usually ivory, beige, rarely with a pinkish tinge, usually strongly pruinose, rarely weak or absent, phenocorticate; entire thallus filled with an abundance of calcium oxalate (H_2SO_4+ forming needle shaped crystals).

APOTHECIA—Lecideine, (0.3–)0.5–1.1(–1.4) mm in diameter, immersed, becoming adnate with age; proper margin black, thin, ± persistent, excluded with age; disc black, usually with a fine white pruina, plane, becoming slightly convex with age; exciple narrow, poorly differentiated, of the *aethalea*-type (**Fig. 5C**) *sensu* Scheidegger (1993), i.e. inner excipular hyphae narrow, hyaline, prosoplectenchymatous (*textura oblita*), often reduced, similar in structure and orientation to the paraphyses, transient with the deep reddish brown hypothecium (*leptoclinoides*-brown, *textura intricata*), outer excipular hyphae parallel, moderately swollen (*textura oblita*) and moderately carbonized with various amounts of brown and aeruginose pigments (cf. *elachista*-brown & *cinereorufa*-green), pigmentation ± continuous with the epihymenium; hymenium hyaline, not inspersed; paraphyses simple to moderately branched, apically swollen, with a brown pigment cap (cf. *elachista*-brown) and a diffuse, aeruginose pigment (HNO_3+ violet, *cinereorufa*-green).

ASCI—8-spored, clavate, *Bacidia*-type. **ASCOSPORES (Fig. 5E–I)**—oblong to narrowly oblong, very rarely constricted, with obtuse ends, not curved, (13.0–)16.3–[18.6]–20.9(–25.0) x (6.0–)6.2–[7.1]–8.0(–10.0) μm (n = 60); one-septate, proper septum briefly thickened but very soon becoming reduced during spore ontogeny, lateral wall thickenings absent (± *Physconia*-type); ornamentation microrugulate (to faintly striate); septum with septal pore canal, simple pore and undifferentiated pore plug; spore wall (**Fig. 5G**) differentiated into smooth to indistinctly cracked, thick perispore (0.30–0.40 μm), narrow intermediate layer (< 0.03 μm), thick proper spore wall (0.35–0.53 μm) and moderately thickened endospore (0.18–0.30 μm).

PYCNIDIA—Rare, urceolate to globose, unilocular, at maturity almost entirely occupied by densely branched conidiophores; conidiogeneous cells mostly terminal, rarely also intercalary (cf. conidiophore-type V *sensu* Vobis 1980); pycnidial ontogeny similar to the *Umbilicaria*-type (sensu Vobis 1980 and Vobis & Hawksworth 1981); conidia simple, bacilliform, 3.0–4.5x 1.0–1.5 μm (n = 20).

CHEMISTRY—Typically with the depside atranorin and traces of the depsidone norstictic acid. Several xanthones have also been detected with HPLC by J. Elix: 4, 5-dichloronorlichexanthone, arthothelin, thiophanic acid. However, the thallus does not react C+ orange and the UV-fluorescence is only faint, possibly obscured by the large amount of Ca-oxalate pruina on the thallus surface. Thalli usually react K+ yellow, rarely K+ yellow-red (forming orange, needle-shaped crystals if observed in the compound microscope), P ± yellow, C– , KC–, CK–. UV± pale yellow to beige. Thallus and apothecia react strongly amyloid.

SUBSTRATE AND ECOLOGY—On limestone (HCl+ strongly reacting) or sandstone with some traces of carbonates (HCl+ weakly reacting, rarely HCl–).

DISTRIBUTION (Fig. 6)—Currently known only from the U.S.A. (Utah, New Mexico, Colorado, Northern Arizona, California).

NOTES—The thick, pruinose, areolate to sublobate, deeply amyloid thalli of *B.*

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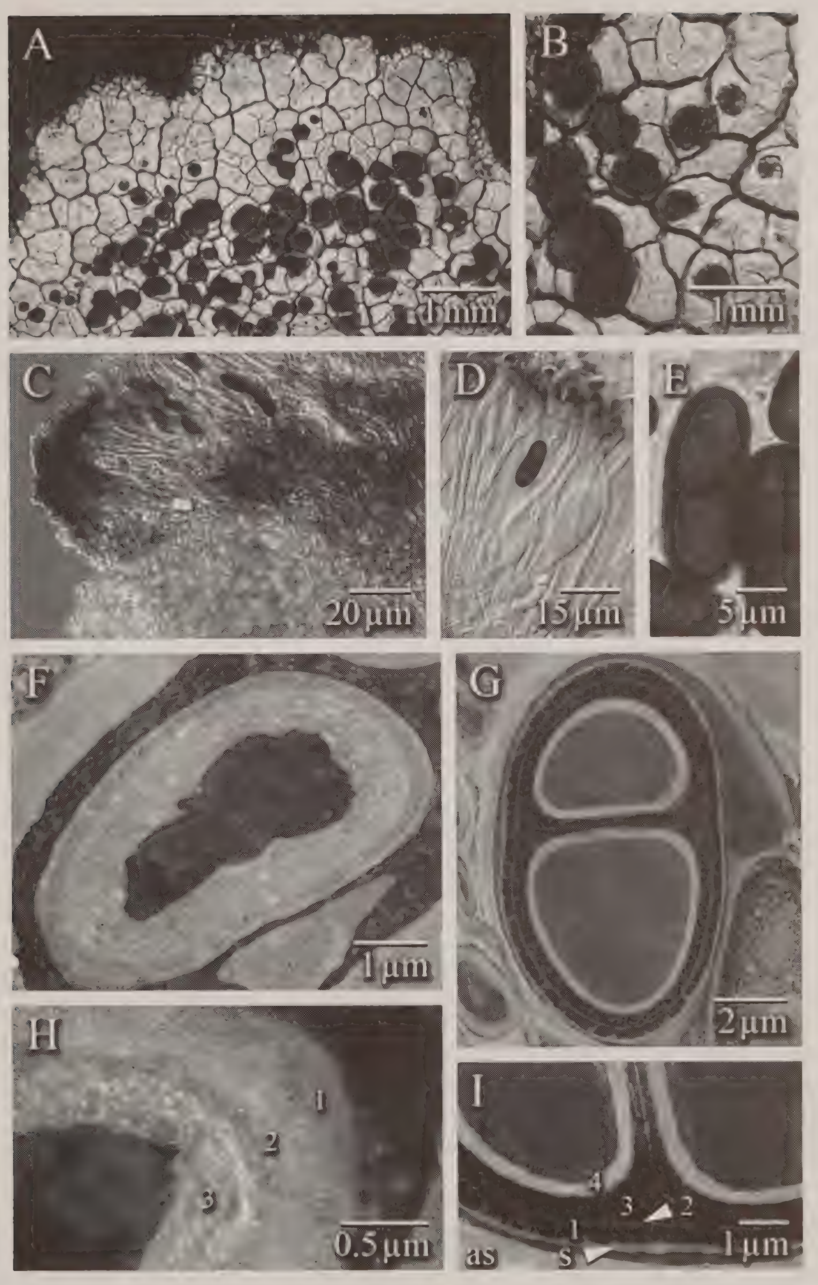
Fig. 5: *Buellia navajoensis.*—A. Overview of areolate thallus (Nebecker *1581*).—B. Close-up of areolate thallus (Nebecker *1581*).—C. Cross section of an apothecium with *aethalea*-type exciple (Nebecker *1581*).—D. Hymenium with asci, paraphyses and one ascospore (Nash *1581*).—E. Mature ascospore: an indistinct septum can be seen in some of the spores (Nash *1581*).—F. Immature ascospore prior to septum formation (Nash *1577* – holotype).—G. Mature ascospore (Nash *1577* – holotype).—H. Wall layers in an immature ascospore: (1) outer layer (perispore and mucilaginous sheath not distinctly differentiated); (2) proper spore wall and (3) endospore beginning to become differentiated (Nash *1577* – holotype).—I. Wall layers in a mature ascospore: (as) ascus wall; (s) mucilaginous sheath; (1) perispore; (2) intermediate layer; (3) proper spore wall; (4) endospore (Nash *1577* – holotype).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navajoensis are very distinct and specimens are not easily confused with other species. Type specimens collected by Nebecker were originally identified as *B. retrovertens* but do not resemble that species. Although the species is very distinct, only a few specimens have so far been collected.

REPRESENTATIVE SPECIMENS EXAMINED—UNITED STATES. Arizona Apache Co. Nash *9111* (ASU). **California. San Bernardino Co.** Nash *10350* (ASU). **Colorado. Larimer Co.** Ryan *12132* (ASU). **New Mexico. San Juan Co.** Marsh *12* (ASU). **Utah Grand Co.** Ryan *11636* (ASU). **Utah. Kane Co.** Nebecker *1581*, *1574*, *1580* (ASU).

Buellia regineae Bungartz sp. nov. **FIGURE 7**

Thallus saxicolus, crustaceus, areolatus vel bullato-areolatus, crassus, eburneus, cum hypothallo atero. Apothecia sessilia, lecideina, marginibus propriis tenuis. Excipulum tenuis, fulvum, sine pigmento aeruginoso, carbonaceum. Asci 8-spori. Sporae uniseptae, oblongae vel ellipsoideae, septibus incrassatus 11–19 x 5.5-10 µm. Pycnidia globosa. Conidia bacilliformes, 4-5 x 0.5-1.0 µm. Thallus atranorina, gangaleoidina, diploicina, fulgidina et acida haematommica et virensica continens. Medulla amyloideus.

Etymology: The species is dedicated to my sister Regine. The species epithet "*regineae*" also reminds of the superficially similar but not closely related *Buellia capitis-regum* W.A. Weber, which has a similarly "gnarled" thallus surface.

Type: MEXICO. Baja California. Isla de Guadalupe, along west coast at "Fondeadero del Oeste" near light, 28°58'50"N, 118°18'50"W, on N-facing cliffs above the ocean, on basalt, *ca.* 80 m alt., 1 January 1996, Nash *38303* (ASU! – holotype designated here).

THALLUS (Fig. 7A, B)—Crustose, distinctly thickened, ± continuous, epilithic; bullate-areolate, thallus surface "gnarled"; prothallus distinct, delimiting the thallus as a black outline; thallus surface smooth (but often eroded in herbarium specimens), matt or ± shiny, usually white to pale ivory, rarely whitish gray, epruinose, phenocorticate; lacking crystals within thallus medulla (H_2SO_4–).

APOTHECIA—Lecideine, (0.3–)0.6–1.1(–1.4) mm in diameter, soon sessile; proper margin thin, black, rarely persistent, soon excluded with age; disc black, epruinose, plane, sometimes ± convex with age; proper exciple of the *dispersa*-type (**Fig. 7C**) *sensu* Scheidegger (1993), i.e. inner exciple distinct, not reduced, hyphae pigmented, prosoplectenchymatous (*textura oblita*), extending from the deep reddish brown hypothecium (*leptoclinoides*-brown, *textura intricata*); outer excipular hyphae short-

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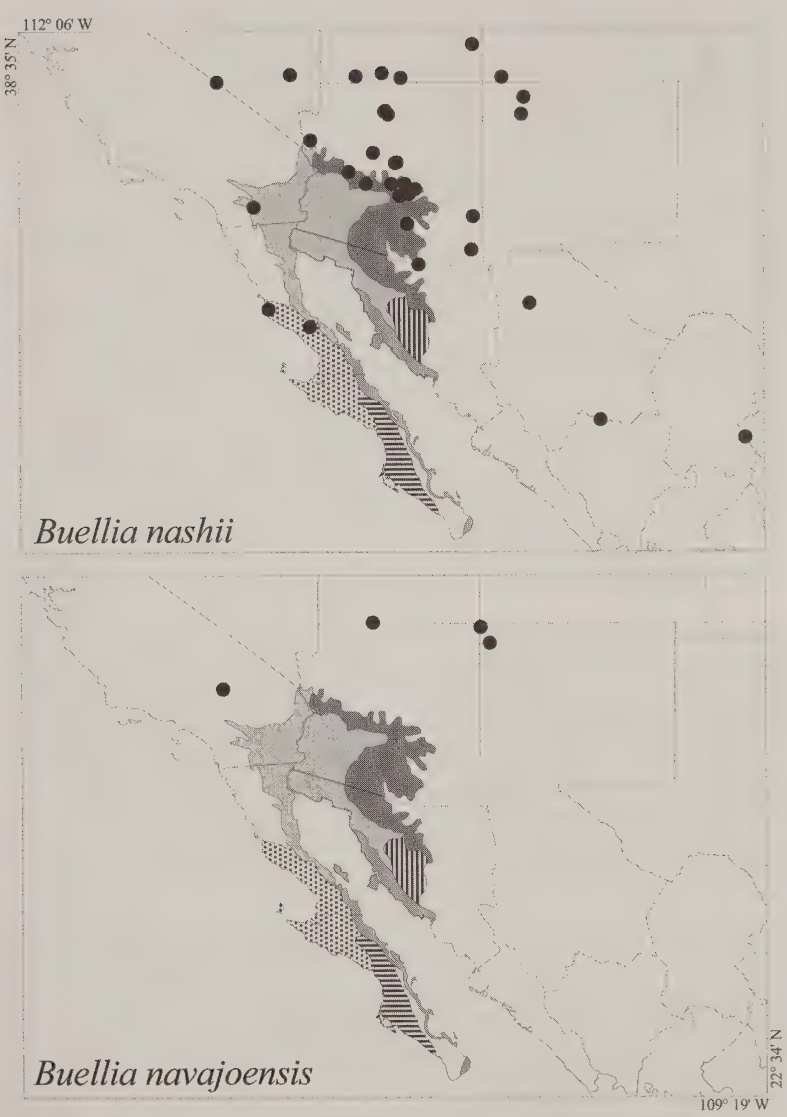
Fig. 6: Distribution of *Buellia nashii* and *Buellia navajoensis* in the Sonoran Desert Region (Floristic Provinces according to Shreve & Wiggins 1964).


112° 06' W
38° 35' N
Buellia nashii
Buellia navajoensis
22° 34' N
109° 19' W

Subdivisions of the Sonoran Desert Floristic Province (Shreve & Wiggins 1964):

▩ Arizona Upland

▤ Magdalena Region

▩ Central Gulf Coast

▨ Lower Colorado Region

▥ Plains of Sonora (including Foothils of Sonora)

▒ Vizcaíno

celled, cells angular, distinctly swollen (*textura angularis*) and usually ± carbonized with various amounts of a brown pigment (cf. *elachista*-brown), pigmentation continuous with the epihymenium; hymenium hyaline, inspersed with oil droplets; paraphyses simple to moderately branched, apically swollen, with a brown pigment cap (cf. *elachista*-brown).

ASCI—8-spored, clavate, *Bacidia*-type. **ASCOSPORES (Fig. 7D–F)**—oblong to ellipsoid, usually not constricted, with obtuse ends, not curved, (11.0–)12.8–[14.6]–16.3(–19.0) x (5.5–)6.4–[7.4]–8.4(–10.0) μm (n = 60); one-septate, proper septum distinctly and ± persistently thickened during spore ontogeny, lateral wall inconspiciously thickened (± *Callispora*-type); ornamentation absent (not visible in DIC); septum with septal pore canal, simple pore and undifferentiated pore plug; spore wall (**Fig. 7F**) differentiated into smooth, thin perispore (0.06–0.09 μm), indistinct intermediate layer (< 0.01 μm), moderately thickened proper spore wall (0.26–0.30 μm) and thick endospore (0.23–0.41 μm).

PYCNIDIA—Infrequent, globose, unilocular, at maturity almost entirely occupied by densely branched conidiophores; conidiogeneous cells mostly terminal, rarely also intercalary (cf. conidiophore-type V *sensu* Vobis 1980); pycnidial ontogeny similar to the *Umbilicaria*-type (sensu Vobis 1980 and Vobis & Hawksworth 1981); conidia simple, bacilliform, 4.0–5.0x 0.5–1.0 μm (n = 20).

CHEMISTRY—The depsides atranorin and chloroatranorin together with various artifacts from hydrolysis of atranorin (chlorohaematommic acid, haematommic acid, methyl-β-orsellinate) have been detected. Other biosynthetically related depsides found in the specimens are: gangaleoidin, norgangaleoidin, chlorolecidioidin, dechlorogangaleoidin. One specimen contains brialmontin 1. The following biosynthetically related depsidones were detected: diploicin, 3-dechlorodiploicin, fulgidin and isofulgidin. One specimen contains virensic acid. (HPLC by J. Elix, Canberra). K+ deep yellow, P+ faintly yellow, C–, KC–, CK–. UV+ bright yellow. The thallus medulla and the apothecia react strongly amyloid.

SUBSTRATE AND ECOLOGY—Growing on siliceous mineral-poor coastal rock (generally HCl–).

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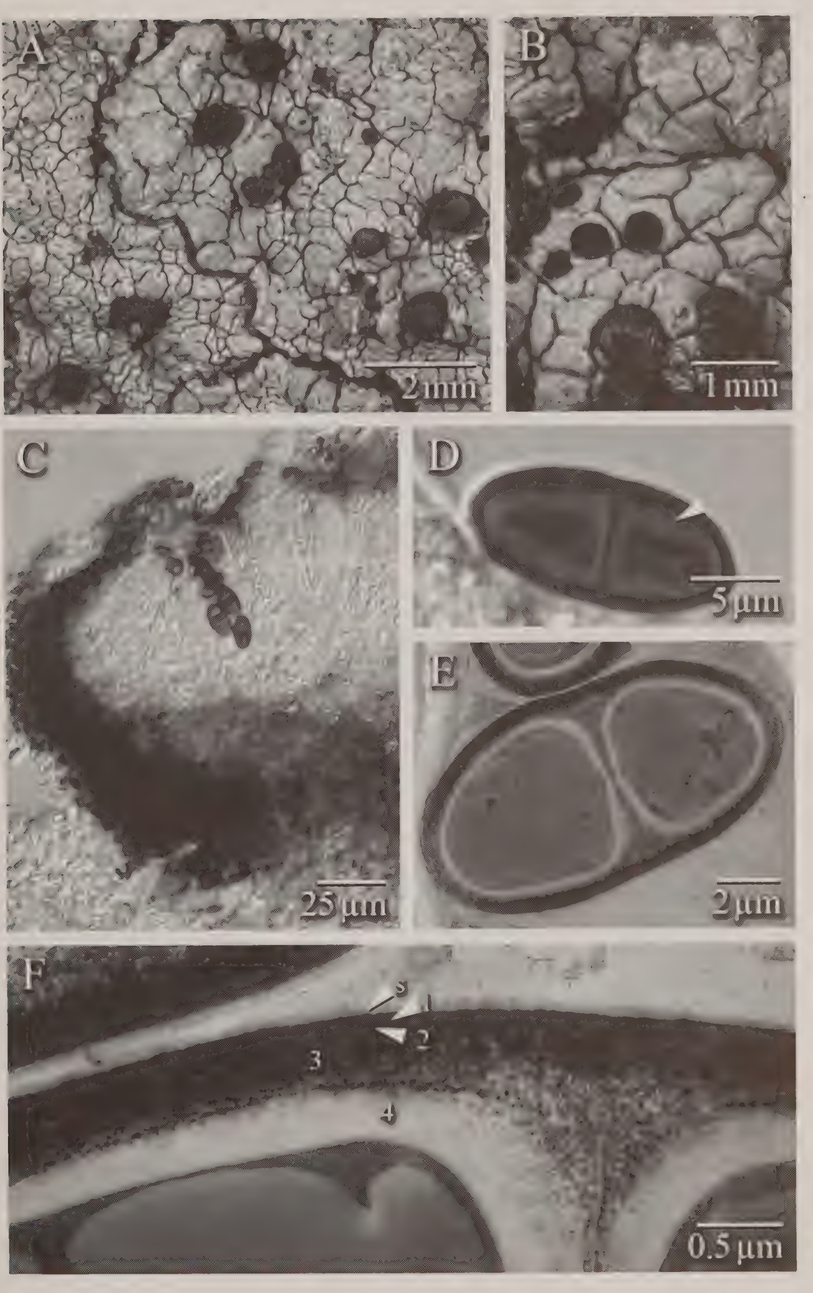
Fig. 7: *Buellia regineae*.—A. Overview of the bullate-areolate thallus outlined by a distinct black prothallus (Wetmore *75787*).—B. Close-up of the thallus (Wetmore *75787*).—C. Apothecium with inspersed hymenium and *dispersa*-type exciple (Wetmore *63682*).—D. Mature ascospore with indistinct lateral wall thickenings (arrow; Weber *Exs. 89*).—E. Mature ascospore (Nash *34319*). — F. Wall layers in a mature ascospore: (s) mucilaginous sheath; (1) perispore; (2) indistinct, narrow intermediate layer; (3) proper spore wall; (4) endospore (Nash *34319*).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DISTRIBUTION (Fig. 9)—Currently known only from the coast of Baja California and southern California.

NOTES—*Buellia regineae* is closely related to a group of species, which are commonly treated within *Hafellia*, a genus described by Kalb (1986) to accommodate species with an oil inspersed hymenium and conspicuous lateral spore wall thickenings. Etayo & Marbach (2003, p. 373) also emphasize that all species of *Hafellia* have "… strongly branched paraphyses (forming an epithecium) …" and typically occur in habitats with high humidity. Most species included in the genus are corticolous. *Hafellia* thus appears very distinct from species related to *Buellia aethalea*, which is often regarded as the core group of the genus *Buellia*.

Unfortunately this concept is currently in direct violation of the Botanical Code as adopted in 1999 in St. Louis (Greuter *et al.* 2000). This currently accepted code lists *Buellia disciformis* as the type of the conserved genus *Buellia*. The listed type clearly belongs to *Hafellia* and was included within that genus by Marbach & Mayrhofer (in Marbach 2000). This transfer is formally invalid because a listed type of one genus (i.e. *Buellia*) cannot belong to another genus (i.e. *Hafellia*). To avoid taxonomic upheaval Moberg et al. (1999) proposed to change the listed type from *B. disciformis* to *B. aethalea*. The majority of lichen taxonomists readily accept the genus *Hafellia* (Birkbeck et al. 1990, Eriksson et al. 2002, Etayo & Marbach 2003, Hafellner & Türk 2001, Kalb 1986, Marbach 2000, Pusswald et al. 1994, Scheidegger 1991, Scheidegger 1993, Sheard 1992, Sheard & Tønsberg 1995). In contrast, Nordin (2000) adopted a very broad concept of *Buellia* suggesting that the proposal to change the listed type will most likely be rejected. Rico et al. (2003) went even further arguing that the acceptance of the most recent code implies that *Hafellia* must be treated as a synonym of *Buellia* s.str. Until a decision on the proposal submitted by Moberg et al. (1999) has formally been reached, species with affinities to *Hafellia* must therefore be included within *Buellia* s.l.

Buellia regineae is closely related to *B. leptoclinoides* (Nyl.) J. Steiner (= *Hafellia leptoclinoides* (Nyl.) Scheid. & H. Mayrhofer *nom. illegit.*). Material of *B. leptoclinoides* was examined for comparison from M and the private herbarium of C. Scheidegger. The specimens have a more distinct lateral wall thickening than *B. regineae*. Nevertheless both species are very similar but the medulla of *Buellia regineae* reacts strongly amyloid and specimens contain fulgidin, isofulgidin and diploicin instead of placodiolic acid. Both species are saxicolous, which is unusual given that the majority of related species appears to be corticolous. Paraphyses of both *B. regineae* and *B. leptoclinoides* are not considerably different from other saxicolous species and a distinct layer on the surface of the hymenium could not be observed (i.e. a distinct epithecium is absent). Thalli growing close to the seashore and subject to spray often have more exuberant areoles and look "gnarled".

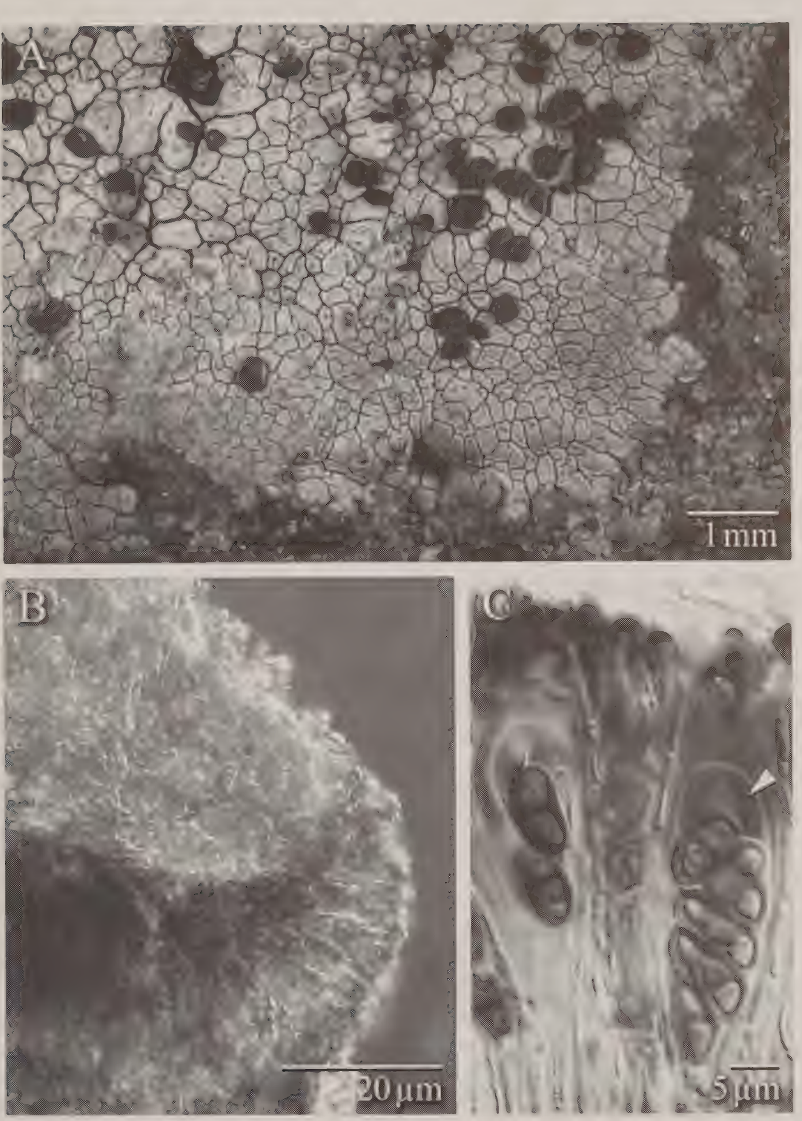

Fig. 8: *Buellia sheardii* (Nash *10086* - holotype).—A. Areolate thallus with sessile apothecia and a black hypothallus.—B. Cross section of an apothecium with *dispersa*-type exciple.—C. Hymenium with *Bacidia*-type ascus (the arrow indicates the characteristic staining of the tholus flanks in Lugol's iodine).

REPRESENTATIVE SPECIMENS EXAMINED—MEXICO. Baja California. Nash *26092*, *26093*, *38303* (ASU); Weber *s.n.* (COLO).

Specimens of *B. leptoclinoides* examined for comparison — FRANCE. Eastern Pyrenees (= Département Pyrenées Orientale). Scheidegger *8480a,b* (hb. Scheidegger); Kalb *Lichenes Neotropici Exs. 372* (M-0061356). **Alsace** (= Département Alsace). Suza *s.n.* (M-0061354). **EUROPE.** unknown locality. Arnold *s.n.* (M-0051355).

Comment: A specimen selected by Meyer & Printzen (2000) as a reference collection for the pigment *leptoclinoides*-brown (Vezda *Lichenes Selecti Exs. 446*; M-0061353) has been erroneously identified as *H. leptoclinoides*. The specimen in M belongs to *B. saxorum*. The same pigment is nevertheless present in this specimen and it is unnecessary to change the reference collection for this pigment.

Buellia sheardii Bungartz, sp. nov. FIGURE 8

Thallus saxicolus, crustaceus, areolatus, tenuis vel crassus, eburneus, cum hypothallo atero. Apothecia sessilia, lecideina, marginibus propriis crassis. Excipulum crassum, fulvo-caeruleum, pigmentum aeruginosum continens, carbonaceum. Asci 8-spori. Sporae uniseptae, oblongae vel ellipsoideae, septibus angustus, 8–13.5 x 4-6 µm. Pycnidia globosa. Conidia bacilliformes vel fusiformes, 6-9 x 1.0-1.5 µm. Thallus acida norstictica et connorstictica continens. Medulla amyloideus.

Etymology: The species is named to honor Dr. John W. Sheard for his outstanding contributions to the taxonomy of *Rinodina* and *Buellia*.

Type: MEXICO. Sinaloa. Topolobampo, near Gulf of California on north-facing hillside, on basalt, ca. 30 m alt., 20 March 1975, Nash *10086* (ASU! – holotype designated here, one isotype at MEXU, one isotype at US).

THALLUS (Fig. 8A, B)—Crustose, thin to moderately thickened, ± continuous, epilithic; areolate; prothallus distinct, delimiting the thallus as a black outline, rarely also between the areoles; thallus surface matt and dull, usually ivory, rarely pale beige, pruinose, phenocorticate; entire thallus with large mineral crystals (*ca.* 40–60 µm in diameter; H_2SO_4–, not forming needles).

APOTHECIA—Lecideine, (0.2–)0.3–0.6(–0.8) mm in diameter, soon adnate to sessile; proper margin prominent, black or rarely masked by grayish remains of necrotic thalline

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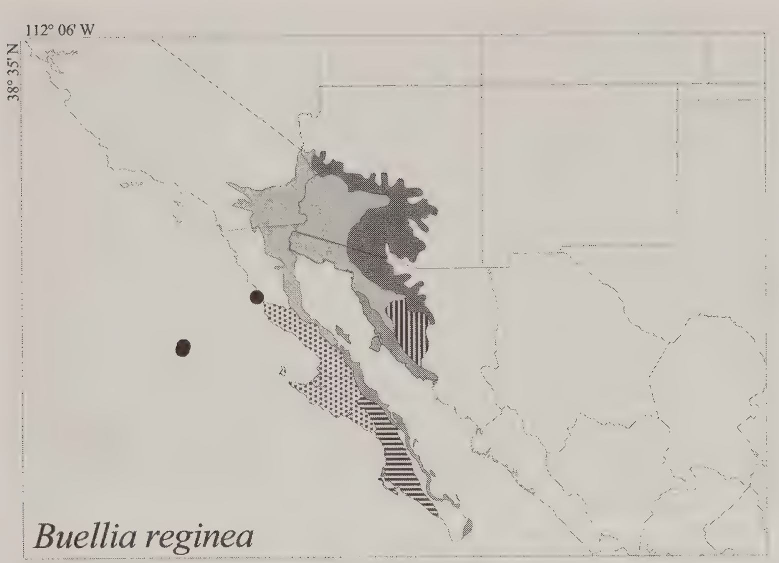
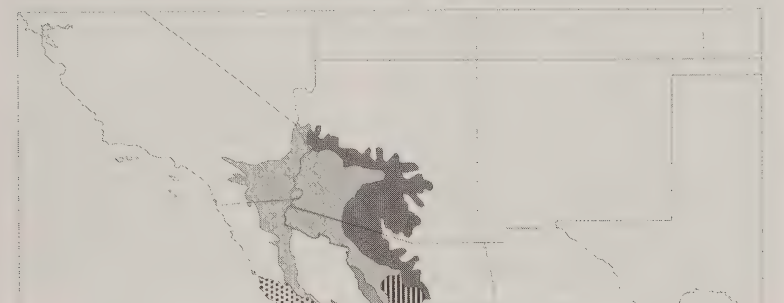
Fig. 9: Distribution of *Buellia regineae* and *Buellia sheardii* in the Sonoran Desert Region (Floristic Provinces according to Shreve & Wiggins 1964).



Buellia reginea



Buellia sheardii

Subdivisions of the Sonoran Desert Floristic Province (Shreve & Wiggins 1964):

▩ Arizona Upland

☰ Magdalena Region

▨ Central Gulf Coast

▨ Lower Colorado Region

▥ Plains of Sonora (including Foothils of Sonora)

▦ Vizcaíno

material (thalline veil), ± persistent, rarely excluded with age; disc black, epruinose or faintly pruinose, plane, becoming only slightly convex with age; proper exciple of the *dispersa*-type (**Fig. 8B**) *sensu* Scheidegger (1993), i.e. inner excipular hyphae distinct, not reduced, pigmented, prosoplectenchymatous (*textura oblita*), extending from the deep reddish brown hypothecium (*leptoclinoides*-brown, *textura intricata*); outer excipular hyphae short-celled, cells angular, distinctly swollen (*textura angularis*) and usually ± carbonized with various amounts of brown and aeruginose pigments (cf. *elachista*-brown and *cinereorufa*-green, HNO_3+ violet), pigmentation continuous with the epihymenium; hymenium hyaline, not inspersed; paraphyses simple to moderately branched, apically swollen, with a brown pigment cap (cf. *elachista*-brown) and a diffuse aeruginose pigment (HNO_3+ violet, *cinereorufa*-green).

ASCI (Fig. 8C)—8-spored, clavate, *Bacidia*-type. **ASCOSPORES (Fig. 8C)**—oblong to ellipsoid, usually not constricted, with obtuse ends, not curved, (8.0–)8.8–[10.2]–11.6(–13.5) x (4.0–)4.1–[4.8]–5.5(–6.0) μm (n = 39); one-septate, proper septum narrow, not thickening during spore ontogeny, lateral wall thickenings absent [*Beltraminea* (=*Buellia*)-type]; ornamentation absent (not visible in DIC).

PYCNIDIA—Rare, globose, unilocular, at maturity almost entirely occupied by densely branched conidiophores; conidiogeneous cells mostly terminal, rarely also intercalary (cf. conidiophore-type V *sensu* Vobis 1980); pycnidial ontogeny similar to the *Umbilicaria*-type (*sensu* Vobis 1980 and Vobis & Hawksworth 1981); conidia simple, bacilliform to fusiform, 6.0–9.0 x 1.0–1.5 μm (n = 20).

CHEMISTRY—With the biosynthetically related depsides atranorin and chloroatranorin and the depsidones norstictic and connorstictic. Thallus usually K+ yellow to red (orange, needle-shaped crystals forming in the compound microscope), P– or + yellow, C–, KC–, CK–. UV– (dark). The thallus and apothecia react amyloid.

SUBSTRATE AND ECOLOGY—Growing on siliceous mineral-poor coastal rock (generally HCl–).

DISTRIBUTION (Fig. 9)—Currently known only from the coast of Sinaloa, along the Gulf of California (Sea of Cortez).

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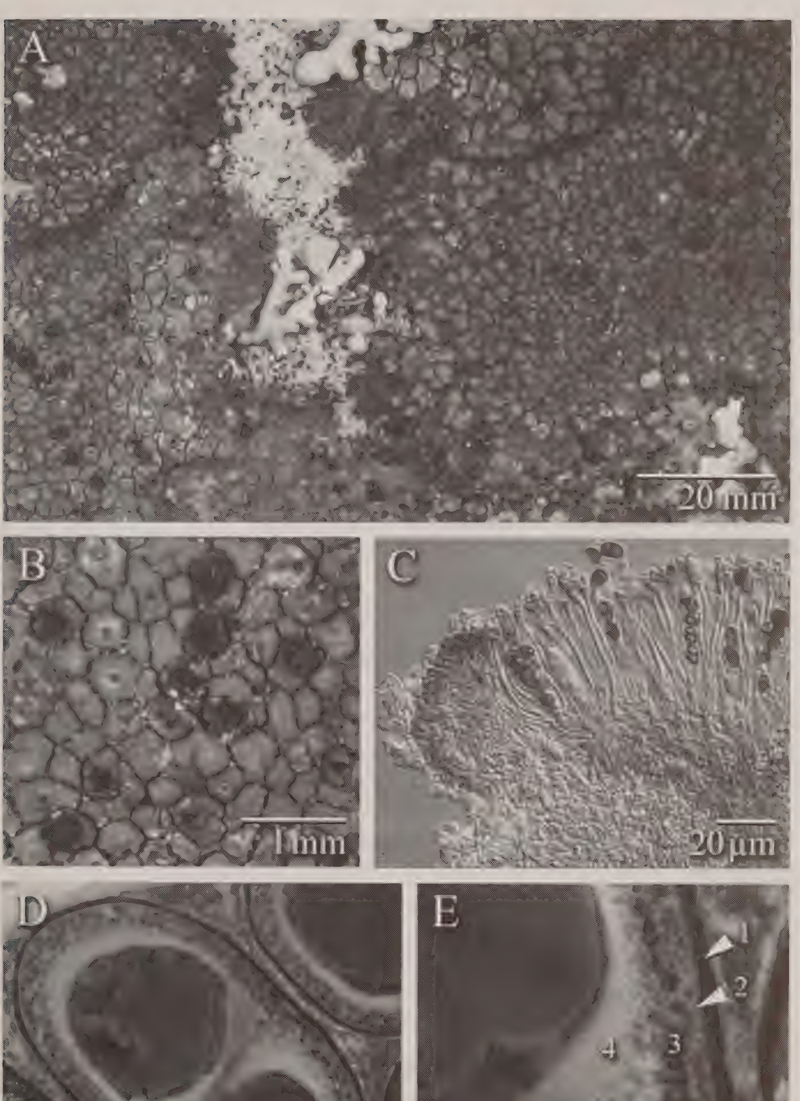
Fig. 10: *Buellia tyrolensis*.—A. Overview of the areolate thallus with black hypothallus (Nash *10987*).—B. Close-up of the thallus (Nash *10987*).—C. Cross section with *aethalea*-type exciple (Ryan *10987*).—D. Mature ascospore (Bungartz *1575*): The endospore appears considerably thickened in the TEM at this stage of the spore ontogeny although no septal thickening is visible in the light microscope.—E. Wall layers in a mature ascospore: (1) perispore; (2) indistinct, narrow intermediate layer; (3) proper spore wall; (4) endospore (Bungartz *1575*).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NOTES—Because of the plane apothecia with a ± persistent margin *B. sheardii* superficially resembles *B. disciformis*, which, however, has a rimose-areolate rather than a distinctly areolate thallus, ascospores with median septum thickenings and does not contain *cinereorufa*-green in the exciple.

ADDITIONAL SPECIMEN EXAMINED—MEXICO. **Sinaloa.** 39 km N of Los Mochis along route 15; 26°07'N, 109°03'W; 60 m, Nash *12088* (ASU).

Buellia tyrolensis Körb., Parerg. Lich.: 187 (1860) **FIGURE 10**

Type: ITALY. Trentino (= South Tirol). Naifthale bei Meran, *ca.* 46°40'N 11°09'E, 1853, Bamberger *ex* hb. Heufl *s.n.* (UPS – isotype).

Taxonomic note: The "Parerga Lichenologica" was issued in several "Lieferungen" beginning with pages 1-96 in 1859. Pages 97-192 were first published in the following year (1860) with the species description of *Buellia tyrolensis* on page 187. Zahlbruckner (1931) and Scheidegger (1993) both use the spelling "*tirolensis*" and cite page 460 instead of page 187. However, on page 460 (first published in 1865) no species of the genus *Buellia* is treated. According to Articles 60.1 and 60.4 of the code (Greuter et al. 2000) the original spelling with "*y*" as *Buellia tyrolensis* is to be maintained and must not be changed to "*tirolensis*".

= *Buellia buellioides* (Metzler *ex* Arnold) Buschardt, Bibl. Lich. 10: 86 (1979) ≡ *Rinodina buellioides* Metzler in Arnold, Verh. zool. bot. Ges. Wien 23: 112 (1873) *comb. novum pro Buellia fusca sensu* Arnold *nom. illegit.*, Verh. zool. bot Ges. Wien 22: 291 (1872) *Type*: ITALY. Trentino (= South Tirol). On porphyric rocks above Gries near Bozen, 46°31'N, 11°19'60''E [original label data: An Porhyrfelsen oberhalb Gries bei Bozen in Südtirol], 29 August 1872, Arnold *Exs. 495* (M-0061319! – lectotype selected here; M-0061317! – isoletotype). Note: Buschardt (1979) did not specify a type from Arnold's *exsiccati* collection and the specimen with the barcode M-0061319 is therefore selected here as the lectotype.

= *Buellia fusca* (Anzi) Kernst., Zeitschr. Ferdinandeums 35: 306 (1893) ≡ *Buellia spuria* var. *fusca* Anzi, Cal. Lich. Sondr.: 87 (1860). *Type:* ITALY. Lombardia. On silicious rock near Comun Nuovo (San Martino), 46°46'60''N, 11°13'E [original label data: Ad rupes silaceas prope Novum-Comum (S. Martino)], Anzi *s.n.* [Lich. Lang. *no. 195*] (M-0061318!, BERN, UPS, W – isotypes)

= *Buellia novomexicana* de Lesd., Ann. Crypt. Exot. 5(2): 128 (1932). *Type*: not found, probably destroyed in Word War II.

= *Buellia novomexicana* f. *pruinosa* de Lesd., Ann. Crypt. Exot. 5(2): 129 (1932). *Type*: U.S.A. New Mexico. San Miguel Co. Near Las Vegas. Gallinas South Canyon, 34°04'N 107°01'W, on silicious rocks, 1870 m [original label data: New Mexico. Environs de Las

Vegas: Canon Sud, sur roches silicieuses], 14 April 1927, Arsène Brouard s.n. (ex hb. Vezda, STU! – lectotype selected here). Note: Type material of *forma pruinosa* from STU was the only material available. This material is selected here as the lectotype because de Lesdain's holotype collection, originally located in Dunkerque (France), was probably destroyed during the Second World War.

= *Buellia zapotensis* de Lesd., Lichens du Mexique: 26 (1914). *Type*: MEXICO. MICHOACÁN. Morelia. Small hills west of Zapote hill, 19°41‘60“N, 101°7‘W, 1900 m [original label data: Morelia. lomas à l'ouest de la loma del Zapote, 1900 m], 2 February 1910, Arsène Brouard *3701* (US! – lectotype selected here). Note: The lectotype specimen selected here from a duplicate of the original collection, has a non amyloid medulla (I–) contrary to the protologue.

For additional not verified synonyms see Scheidegger (1993).

THALLUS (Fig. 10A, B)—Crustose, thin to moderately thickened, ± continuous, epilithic; areolate; prothallus conspicuously black, in most specimens strongly developed and growing between the areoles (forming a hypothallus), rarely only surrounding the thallus outline; thallus surface matt and smooth, rarely ± shiny, usually deep brown, rarely olive brown, epruinose, phenocorticate; lacking crystals within the thallus medulla (H_2SO_4–).

APOTHECIA—Lecideine, (0.2–)0.3–0.4(–0.5) mm in diameter, remaining immersed to indistinctly adnate; proper margin prominent, black or masked by grayish remains of necrotic thalline material (thalline veil), usually persistent, rarely excluded with age; disc black, epruinose, rarely with a faint white pruina, plane, rarely becoming slightly convex with age; proper exciple narrow, poorly differentiated, of the *aethalea*-type (**Fig. 10C**) *sensu* Scheidegger (1993), i.e. inner excipular hyphae narrow, hyaline, prosoplectenchymatous (*textura oblita*), often reduced, similar in structure and orientation to the paraphyses, transient with the deep reddish brown hypothecium (*leptoclinoides*-brown, *textura intricata*), outer excipular hyphae parallel, moderately swollen (*textura oblita*) and usually strongly carbonized with various amounts of a brown pigment (cf. *elachista*-brown), pigmentation continuous with the epihymenium; hymenium hyaline, not inspersed; paraphyses simple to moderately branched, apically swollen, with a brown pigment cap (cf. *elachista*-brown).

ASCI—8-spored, clavate, *Bacidia*-type. **ASCOSPORES (Fig. 10D, E)** – oblong to ellipsoid, usually not constricted, with obtuse ends, not curved, (9.0–)9.4–[10.4]–11.3(–15.0) x (5.5–)5.8–[6.2]–6.7(–8.0) μm (n = 60); one-septate, proper septum narrow, not thickened during spore ontogeny, lateral wall thickenings absent [± *Beltraminea* (=*Buellia*)-type]; ornamentation absent (not visible in DIC); septum with septal pore canal, simple pore and undifferentiated pore plug; spore wall (**Fig. 10E**) differentiated into smooth, thin perispore (0.08–0.15 μm), very narrow intermediate layer (< 0.20

μm), thick proper spore wall (0.25–0.50 μm) and thick endospore (0.16–0.68 μm).

PYCNIDIA—Rare to common, urceolate to globose, unilocular, at maturity almost entirely occupied by densely branched conidiophores; conidiogeneous cells mostly terminal, rarely also intercalary (cf. conidiophore-type V *sensu* Vobis 1980); pycnidial ontogeny similar to the *Umbilicaria*-type (sensu Vobis 1980 and Vobis & Hawksworth 1981); conidia simple, bacilliform, 4.5–7.0x 0.5–1.0 μm (*n* = 20).

CHEMISTRY—The thalli contain the biosynthetically related depsidones norstictic and connorstictic acid and/or the depside 2'-*O*-methylperlatolic acid. Spot test reactions are not distinct on the dark thallus and must be confirmed in the compound microscope. K+ yellow to red (± forming orange, needle-shaped crystals) or K– (no crystals), P– or + faintly yellow, C–, KC–, CK–. UV– (dark). The thallus is not amyloid, but apothecia react amyloid in Lugol's (thallus reactions of the dark thallus should be confirmed in the compound microscope).

SUBSTRATE AND ECOLOGY—On a wide variety of silicieous (HCL-) rock, typically on ± shaded and sheltered boulders and cliffs.

DISTRIBUTION (Fig. 12)—Common and widely distributed in montane areas of the Greater Sonoran Desert Region. The species is also known from Mediterranean Europe, where it appears to be quite rare.

NOTES—Generally no distinct thickening of the spore septum has been observed in any of the specimens examined with the light microscope. Scheidegger (1993) therefore assigned the spores to the *Buellia*-type. Unfortunately these observations do not agree very well with specimens examined with the TEM. In the TEM the endospore appears considerably thickened especially along the spore septum. Currently not enough material has been examined to evaluate this discrepancy between light and electron microscopy.

Scheidegger (1993) distinguished *B. fusca* (with 2'-*O*-methylperlatolic acid) from *B. tyrolensis* (with norstictic acid). Although the majority of specimens examined can be divided into these two chemotypes, some specimens with both norstictic and 2'-*O*-methylperlatolic acid have been found. All chemotypes (only norstictic, only 2'-*O*-methylperlatolic and specimens containing both substances) are morphologically and anatomically identical and show no distinctly different distribution patterns. This situation is surprisingly different from *B. stellulata* (with 2'-*O*-methylperlatolic acid, coastal, non amyloid medulla) and *B. spuria* (with norstictic acid, inland, amyloid medulla), where the same lichen substances clearly denote two distinctly different species.

REPRESENTATIVE SPECIMENS EXAMINED—EUROPE. ITALY. TRENTINO (= SOUTH TIROL). Arnold *s.n.* (M-0061312, M-0061314, M-0061316); Doppelbaur *10288* (M-0061320); Metzler *s.n.* (M-0061313, M-0061321). **LIGURIA.** Sbarbaro *s.n.* (MSC-40629,

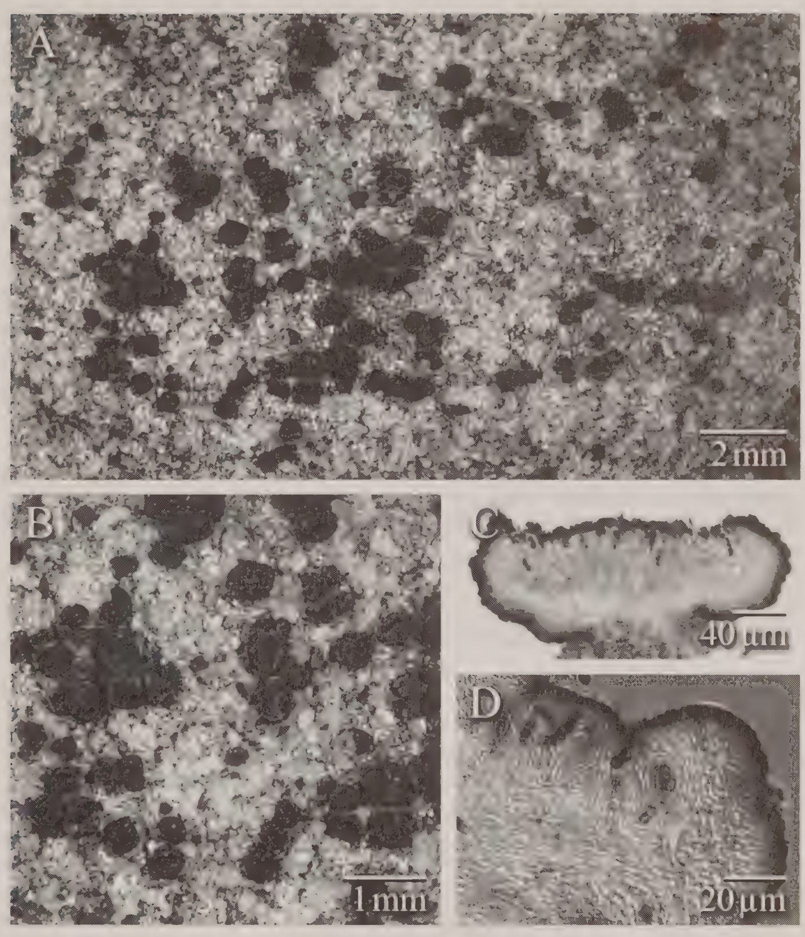


Fig. 11: *Buellia vilis*. — A. Overview of the chasmolithic thallus (Hertel *40242*). — B. Close-up of chasmolithic thallus (Hertel *40242*). — C. Cross section of an apothecium (Marsh *116*). — D. Cross section of an apothecium with *vilis*-type exciple (Marsh *116*).

M-0061315). **SPAIN. Almeria.** Scheidegger *Inv. Nr. 8640* (hb. Scheidegger).—**NORTH AMERICA. MEXICO. Baja California Sur**. Nash *12758*, *39833*, *40016* (ASU). **Chihuahua**. Nash *31198*, *36099*, *36545*, *36677*, *37521*, *37837*, *13508b*, *13720* (ASU). **Sonora**. Nash *25500*, *25611*, *37942*, *12519* (ASU); Nash *11959* (MSC-335429). **UNITED STATES. Arizona**. **Cochise Co.** Hertel *40053a* (M); Lehto *s.n.*, Nash *3703*, *3740*, *3742*, *3821*, Ryan *10961*, *10978*, *10782* (ASU); Weber *s.n.*, *S8782*, *S8782*, *Exs. 408* (COLO); Weber *8782* (MSC-40696); Shushan *8782* (MSC-40696); Shushan *S-8782* (M-0061367). **Gila Co.**

Nash *7400b* (ASU). **Graham Co.** Nash *36043* (ASU). **Pima Co.** Darrow *1448* (ASU); Hertel *39915* (M-0061399); Nash *27406a*, *4090*, *4146*, Ryan *20310* (ASU). **Santa Cruz Co.** Darrow *477*, *821*, Nash *25242*, *25243*, *25355*, *25774*, *13011*, *7161* (ASU); Scheidegger *Inv. Nr. 31-39* (hb. Scheidegger); Schramm *196*, Zschau *s.n.* (ASU). **Colorado. Colorado Co.** Shushan *8185* (MSC-40707). **Missouri. Taney Co.** Wetmore *69088* (MIN). **New Mexico. Doña Ana Co.** Nash *7922* (ASU). **San Miguel Co.** Nash *16048* (ASU). **Sierra Co.** Nash *7116* (ASU). **Soccoro Co.** Shushan *S-6932* (M-0061365). **South Dakota. Custer Co.** Wetmore *10175* (MSC-70750). **Texas. Brewster Co.** Nash *15037a* (ASU); Wetmore *18488b*, *19391* (MIN, M-00613161); Anderson *S-18696* (M-0061366); Wetmore *19417* (MSC-374082); Anderson *18696* (MSC-45835); Shushan *18696* (MSC-45835).

Buellia vilis Th. Fr., Kgl. Vetensk. Akad. Handl. 7(2): 44 (1867) FIGURE 11

Type: NORWAY. SVALBARD (= SPITSBERGEN). On western sea-shore rocks. [original label data: ad saxa litore occidentali], Nordenskjöld *s.n.* (UPS? - type not seen).

Taxonomic note: Type material of Th. Fries at UPS may be lost and a neotype may have to be selected. Scheidegger (1993) also did not see the type. The protologue and the descriptions in Leighton (1868) and Steiner (1907) are, however, very detailed and it can be reasonably assumed that the type shows the same characters as described there.

A specimen from Körber's "Typenherbar" in L is annotated as *B. vilis* (L-0065286). This specimen, however has hyaline, non-septate ascospores and possibly belongs to *Lecidella.*

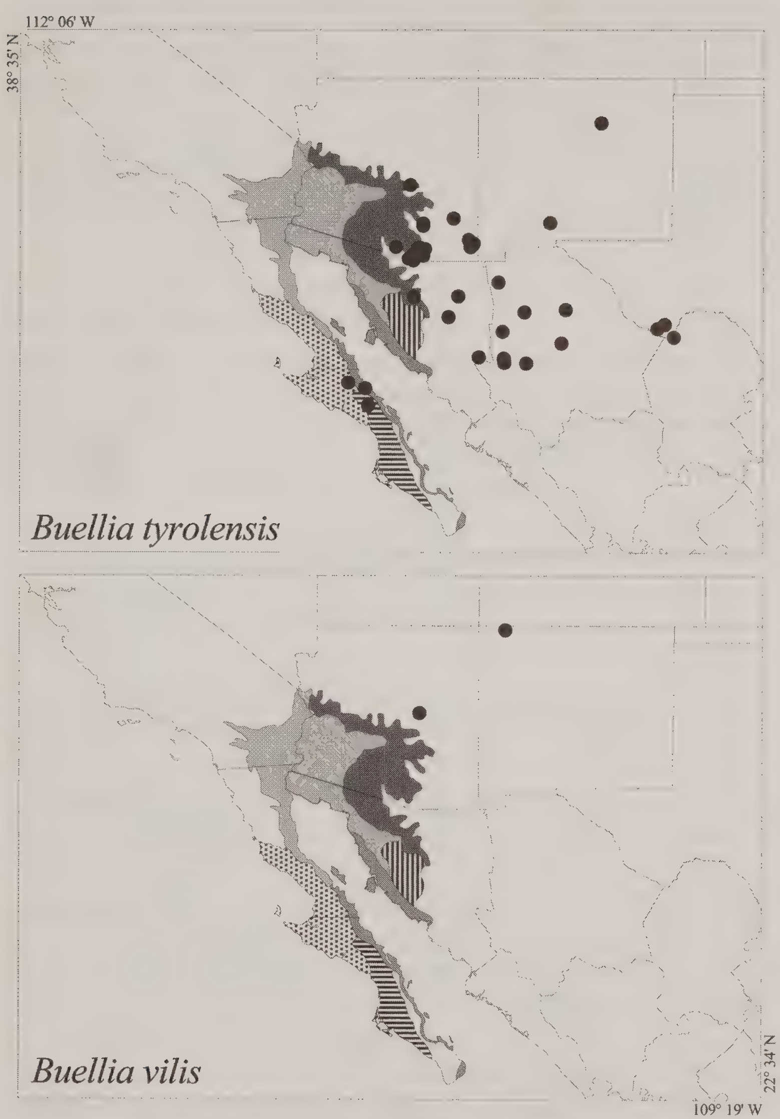
Buellia vilis is *not* closely related to *B. notabilis* Lynge even though the protologue and a description of *B. notabilis* by Thomson (1997) suggest otherwise. A "kleptotype" specimen of *B. notabilis* at MSC has a distinctly epilithic, areolate, gray thallus with a non-amyloid medulla (I-). The lecideine apothecia of this specimen are sunken between the areoles. Because of a *Lecanora*-type ascus and hyaline hypothecium, *B. notabilis* may better be placed into *Rinodina.*

For synonyms of *B. vilis* see Scheidegger (1993).

THALLUS—(Fig. 11A, B) Crustose, thin, discontinuous, hidden, chasmolithic; i. e. forming inconspicuous, poorly delimited granules between the mineral grains of the substrate; prothallus absent; thallus surface matt and dull, not shiny, usually pale gray, rarely pale brown, epruinose, phenocorticate; lacking crystals within thallus medulla (H_2SO_4–).

→

Fig. 12: Distribution of *Buellia tyrolensis* and *Buellia vilis* in the Sonoran Desert Region (Floristic Provinces according to Shreve & Wiggins 1964).


112° 06' W
38° 35' N
Buellia tyrolensis
Buellia vilis
22° 34' N
109° 19' W

Subdivisions of the Sonoran Desert Floristic Province (Shreve & Wiggins 1964):

- ■ Arizona Upland
- ▤ Magdalena Region
- ▩ Central Gulf Coast
- ▨ Lower Colorado Region
- ▥ Plains of Sonora (including Foothils of Sonora)
- ⁘ Vizcaino

Accepted name	Recent Synonym(s)	References
B. aethalea		Bungartz & Nash (2004c). The Bryologist, in press.
B. argillicola		current article
B. badia	*B. turgescens*	Bungartz & Nash (2004b). The Bryologist 107:21-27.
B. christophii		Bungartz, Nash & Ryan (2004a). Can. J. Bot. 82: 540-562.
B. concinna	*B. semitensis*	Bungartz, Elix & Nash (2004b). The Bryologist, in press.
B. dispersa	*B. retrovertens*	Bungartz Scheidegger & Nash (2002) Bibl. Lich. 82: 19-35.
B. eganii		Bungartz & Nash (2004c). The Bryologist, in press.
B. halonia		Bungartz, Elix & Nash (2004b). The Bryologist, in press.
B. lacteoidea		Bungartz & Nash (2004c). The Bryologist, in press.
B. lepidastroidea		current article
B. mamillana	*B. glaziouana*, *B. thomae*	Bungartz, Elix & Nash (2004b). The Bryologist, in press; Weber (1986). Mycotaxon 27:451-497.
B. nashii		current article
B. navajoensis		current article
B. paniformis		Weber (1971). The Bryologist 74:185-191.
B. prospersa	*Amandinea lecideina*	Bungartz, Nash & Ryan (2004a). Can. J. Bot. 82: 540-562.
B. pullata		Bungartz, Nash & Ryan (2004a). Can. J. Bot. 82: 540-562.
B. regineae		current article
B. ryanii		Bungartz, Nash & Ryan (2004a). Can. J. Bot. 82: 540-562
B. sequax	*B. saxicola*	Bungartz, Nash & Ryan (2004a). Can. J. Bot. 82: 540-562, Scheidegger (1993). Lichenologist 25:315-364.
B. sheardii		current article
B. spuria		Bungartz & Nash (2004c). The Bryologist, in press.
B. stellulata		Bungartz & Nash (2004c). The Bryologist, in press.
B. subaethalea		Bungartz, Elix & Nash (2004b). The Bryologist, in press.
B. subalbula	*B. maritima*	Bungartz & Nash (2004a) Bibl. Lich. 88:49-66.
B. subdisciformis		Scheidegger (1993). Lichenologist 25:315-364.
B. tergua		Bungartz, Nash & Ryan (2004a). Can. J. Bot. 82: 540-562.
B. tesserata	*B. fimbriata*, *B. cerussata*	Rico et al. (2003). Lichenologist 35:117-124
B. trachyspora		Bungartz, Elix & Nash (2004b). The Bryologist, in press.
B. tyrolensis	*B. novomexicana*, *B. fusca*	current article
B. uberior		Scheidegger (1993). The Lichenologist 25:315-364, Scheidegger (1987). Botanica Helvetica 97:99-116.
B. vilis		current article

Table 1: References to detailed descriptions of all species known from the Sonoran Desert Region, including recent synonyms.

APOTHECIA—Lecideine, (0.2–)0.5–1.1(–1.2) mm in diameter, soon sessile; proper margin thin, black, usually persistent, rarely excluded with age; disc black, epruinose, plane, ± becoming slightly convex with age; proper exciple of the *vilis*-type (**Fig. 11C, D**) *sensu* Scheidegger (1993), i.e. inner excipular hyphae hyaline (reacting strongly I+ blue), prosoplectenchymatous, loosely interwoven (*textura intricata*), transient with the hyaline hypothecium (reacting strongly I+ blue, *textura intricata*), outer excipular hyphae parallel, thin (*textura oblita*) and usually very strongly carbonized with large amounts of a dull brown-red to blackish pigment (*atra*-red, HNO_3+ deep purple), pigmentation continuous with the epihymenium; hymenium hyaline, not inspersed; paraphyses simple to moderately branched, apically swollen, with a deep brown to black pigment cap (*atra*-red, HNO_3+ deep purple).

ASCI—8-spored, clavate, *Bacidia*-type. **ASCOSPORES**—oblong to ellipsoid, usually constricted (with age), with obtuse ends, not curved, (12.0–)13.1–[14.5]–15.9 (–18.0) x (5.0–)5.7–[6.6]–7.4(–9.0) μm (n = 60); one-septate, proper septum narrow, not thickened during spore ontogeny, lateral wall thickenings absent [*Beltraminea* (=*Buellia*)-type]; ornamentation absent (not visible in DIC).

PYCNIDIA—Very rare, unilocular, at maturity almost entirely occupied by densely branched conidiophores; conidiogeneous cells mostly terminal, rarely also intercalary (cf. conidiophore-type V *sensu* Vobis 1980); pycnidial ontogeny similar to the *Umbilicaria*-type (sensu Vobis 1980 and Vobis & Hawksworth 1981); conidia simple, bacilliform, 4.5–7.0x 0.5–1.0 μm (n = 20).

CHEMISTRY—No substances found with TLC. All spot tests negative (K–, P–, C–, KC–, CK–). UV– (dark). The thallus hyphae react very strongly amyloid like the hyphae in the apothecium (even if tested with low iodine concentrations!).

SUBSTRATE AND ECOLOGY—According to Scheidegger (1993) typicallly found on small pebbles in exposed habitats. The specimens from Arizona and New Mexico were found on sandstone.

DISTRIBUTION (Fig. 12)—The species appears to be extremely rare in the Sonoran Desert Region and is probably restricted to montane to subalpine or even alpine habitats. A single record is currently known from the Mogollon Rim in Arizona. A second specimen, deposited at ASU has been collected at 1768 m elevation outside the Sonoran Region in New Mexico (Rankert *116*).

NOTES—*Buellia vilis* has frequently been reported from the North American Southwest but almost all reports are erroneous and based on misidentifications of *B. sequax* (Nyl.) Zahlbr. (see Bungartz et al. 2004a). Until recently, no single specimen was known from the area (Bungartz & Nash III 2004b). *Buellia vilis* is very isolated even within an expanded genus concept of *Buellia* s.l. because of the unique exciple type characterized by a pigment not found in any other species. The species may best be placed in a monotypic genus but the genus concept in *Buellia* is currently not well resolved and the introduction of new genera may only contribute to further confusion.

REPRESENTATIVE SPECIMENS EXAMINED—AUSTRIA. Tirol. Arnold *s.n.* (M-0061300). **FRANCE. Hautes Pyrenées.** Scheidegger *Inv. Nr. 8056*, 8383, *8498*, *8501* (hb. Scheidegger). **ITALY. Trentino (= South Tirol).** Arnold *s.n.* (M-0061301, M-0061302). **UNITED STATES. Alaska. North Slope Co.** Fryday *8279* (MSC). **Arizona. Cocinino Co.** Hertel *40242* (M). **New Mexico. San Juan Co.** Rankert *116* (ASU).

Key

Saxicolous species of *Buellia* s.l. with one-septate ascospores in the Sonoran Desert Region

1 Thallus parasitic on other lichens **2**

Thallus not parasitic **3**

2(1) Thallus deep brown, bullate-areolate to distinctly squamulose, parasitic on a variety of lichen genera including *Xanthoparmelia*, *Acarospora* and *Dimelaena*, medulla KC–, C– (without secondary metabolites or traces from the host lichen), spore ornamentation indistinct .... ***B. badia*** (Fr.) A. Massal.

Thallus light gray to dark gray, areolate, forming distinct insular patches in *Schaereria fuscocinerea*, medulla KC+ fleeting pink, C+ fleeting pink (medulla with gyrophoric acid), spore ornamentation striate .... ***B. uberior*** Anzi

3(1) Thallus C+ orange, KC+ orange (with xanthones) **4**

Thallus C–, KC– (with or without xanthones) **5**

4(3) Thallus granular to minutely bullate, not areolate; prothallus absent; spores with ± tapered ends, frequently curved and crescent-shaped, rarely not curved and ± citriform; exciple brown (HNO_3–); montane to subalpine .... ***B. concinna*** Th. Fr.

Thallus thick, areolate, usually with a distinct black prothallus along the margin; spores ellipsoid to oblong, with obtuse ends, not curved; exciple aeruginose (HNO_3+ violet); coastal .... ***B. halonia*** (Ach.) Tuck.

5(3) Inner exciple distinctly paraplectenchymatous, formed by large, leptodermatous, ± isodiametric cells; outer exciple very strongly carbonized (small, globular cells barely discernible, even in thin microtome sections); spores with a coarsely rugulate to areolate ornamentation (clearly visible at 400x); rare, subtropical; in the Sonoran Desert Region currently known only from Sinaloa and Chihuahua, Mexico .... ***B. trachyspora*** Vain.

Inner exciple not paraplectenchymatous, formed by mesodermatous hyphae;

outer exciple moderately to strongly carbonized (individual cells discernible, at least in thin microtome sections); spores smooth or ornamented but not coarsely areolate (ornamentation, if present, barely visible at 400x); more widely distributed **6**

6(5) Thallus with a chalky consistency, containing large amounts of Ca-oxalates (clusters of sulphate needles in H_2SO_4); cortex roughened, often strongly pruinose; substrate usually calcareous, (HCl+) **7**

Thallus not chalky, without Ca-oxalates (H_2SO_4–), cortex smooth but sometimes obscured by fine pruina; substrate usually not calcareous (HCl–) **11**

7(6) Medulla amyloid (I+ blue) **8**

Medulla not amyloid (I-) **9**

8(7) Thallus thin, rimose (finely fissured), subeffigurate; bright white; without xanthones; apothecia with thick, persistent, lecideine margin; spores rugulate, oblong to ellipsoid; spore septum not thickening during ontogeny .... ***B. argillicola***

Thallus thick, distinctly areolate (cracked) to sublobate; ivory, pale beige or with faint pinkish tinge; containing xanthones; apothecia with thin, ± reduced lecideine margin; spores microrugulate to faintly striate, oblong to narrowly oblong, spore septum soon, but only briefly thickening during ontogeny .... ***B. navajoensis***

9(7) Thallus rimose to rimose-areolate, ± continuous, usually delimited by distinctly blackened, rarely pale prothallus; apothecia immersed to adnate; exciple narrow, often reduced to few hyphae similar in structure and orientation to the paraphyses, end cells distinctly swollen, with fuscous brown pigment cap and diffuse, aeruginose pigment (HNO_3+ violet), diffuse pigment extending across epihymenium; species restricted to coastal habitats .... ***B. subalbula*** (Nyl.) Müll. Arg.

Thallus areolate to subsquamulose, rarely sublobate, ± continuous to dispersed, not delimited by prothallus; apothecia soon sessile; exciple distinct, strongly developed, inner hyphae pigmented, mesodermatous, extending from reddish brown hypothecium, outer hyphae moderately swollen with fuscous pigment cap, aeruginose pigment absent (HNO_3–) or restricted to outermost exciple cells; widely distributed throughout the Sonoran Desert Region **10**

10(9) Outermost exciple with small amounts of diffuse aeruginose pigment (HNO_3+ violet); thallus usually K+ orange to red (orange, needle-shaped crystals), rarely K+ yellow or K– (no crystals); with norstictic and/or stictic acid .... ***B. nashii***

Outermost exciple cells without diffuse aeruginose pigment (HNO_3–); thallus K– or K+ yellow (no crystals); with 2'-*O*-methylperlatolic acid .... ***B. dispersa*** A. Massal.
(**Note**: A revision of this morphologically variable species group using both classical and molecular data is currently in progress. For a distinction of three morphotypes see Bungartz et al. 2002)

11(6) Thallus indistinct, chasmolithic to endolithic, dispersed granules hidden among mineral crystals or entirely hidden **12**

Thallus distinct, epilithic, establishing a ± continuous crust on the substrate surface **14**

12(11) Spores with ± persistent septum thickenings; thallus pale yellow or whitish, containing xanthones (UV± pale to bright yellow or orange); conidia filiform; restricted to coastal habitats .... ***B. prospersa*** (Nyl.) Riddle
(**Note**: Specimens of *B. prospersa* are usually distinctly epilithic but rarely have a poorly developed and ± discontinuous thallus, which may appear chasmolithic, see Bungartz et al. 2004a)

Spores without septum thickening; thallus absent or white to pale gray, without xanthones (UV– or UV± pale but not bright yellow or orange); conidia bacilliform; not restricted to coastal habitats **13**

13(12) Thallus endolithic to chasmolithic; hyphae strongly amyloid (I+ blackish blue); hypothecium and inner exciple hyaline, outer exciple strongly carbonized with blackish red pigment (HNO_3+ deep purple); spores broadly oblong to ellipsoid; in the Sonoran Region currently known from a single locality (along the Mogollon Rim) .... ***B. vilis***

Thallus chasmolithic; hyphae not amyloid (concentrated I–); hypothecium deep reddish brown, outer exciple weekly carbonized with a brown pigment (HNO_3–); young spores narrowly oblong, becoming ellipsoid with age; common throughout the Sonoran Region .... ***B. sequax***

14(11) Hymenium inspersed with oil droplets (especially in KOH) **15**

Hymenium not inspersed **16**

15(14) Medulla not amyloid (I–); thallus ± continuous to dispersed, apothecia small, usually < 0.8 mm (rarely up to 1.1 mm) in diameter; spores 7–17 x 5–8 μm, with distinct septum thickening but no lateral wall thickenings .... ***B. lepidastroidea***

Medulla amyloid (I+ blue); thallus ± continuous, not becoming dispersed; apothecia large, up to 1.5 mm in diameter; spores 11–19 x 5.5–10 μm, with distinct septum thickening and inconspicuous lateral wall thickenings .... ***B. regineae***

16(14) Thallus granular-areolate to verrucose; each spore cell covered by a broad, darkened band .... ***B. subaethalea*** de Lesd.

Thallus not granular or verrucose, but sometimes bullate or subsquamulose to squamulose; spore cells not covered by darkened bands **17**

17(16) Thallus areolate to squamulose or sublobate; apothecia soon sessile; hypothallus absent **18**

Thallus rimose to areolate, not subsquamulose or sublobate; apothecia immersed, becoming sessile with age; usually with a distinct, black hypothallus, rarely hypothallus absent **21**

18(17) Thallus deep "chocolate" brown, epruinose; forming bullate to subsquamulose areoles or distinct squamules; juvenile thalli frequently parasitic, but becoming independent with age; secondary metabolites absent (or traces from the host lichen) .... ***B. badia***

Thallus not deep brown (ivory, pale brown, olive brown or dark gray); with or without pruina; never parasitic; with various secondary metabolites **19**

19(18) Thallus with diploicin, pale brown to tawny yellow ("*isabelline*") and shiny, rarely with whitish pruina, forming strongly swollen, bullate areoles ("bread-loaves"); epihymenium of immature apothecia shedding a thin epinecral layer when emerging through the thallus surface, exciple of young apothecia with a thin thalline collar, which is soon shed; coastal, rare (currently known only from Guadelupe Island and few localities on the Baja peninsula) ....
.... ***B. paniformis*** W.A. Weber

Thallus without diploicin, areolate to subsquamulose or sublobate; epihymenium not covered by epinecral surface layer, not emerging with a thalline collar; common and widely distributed throughout the Sonoran Region **20**

20(19) Outermost exciple always with small amounts of diffuse aeruginose pigment (HNO_3+ violet); thallus usually K+ orange to red (orange, needle-shaped crystals), rarely K+ yellow or K– (no crystals); with norstictic and/or stictic acid .... ***B. nashii***

Outermost exciple cells without aeruginose pigment (HNO_3–); thallus K– or K+ yellow (no crystals); with 2'-*O*-methylperlatolic acid .... ***B. dispersa***

21(17) Exciple deep brown, without aeruginose pigment (HNO_3–) **22**

Exciple and epihymenium olive brown or bluish green, rarely fuscous brown, always with an aeruginose pigment (HNO_3+ violet) **29**

22(21) Spore septum distinctly thickened during some stages of the ascospore ontogeny **23**

Spore septum not thickened during the entire ascospore ontogeny **25**

23(22) Apothecial disc deep brown, blackening with age; young apothecia lecanorine, becoming lecideine with age (i.e. thalline margin darkening and excluded by expansion of proper exciple), medulla amyloid (I+ blue, test carefully on thin thalli!) .... ***B. mamillana*** (Tuck.) W. A. Weber

Apothecial disc deep black, not brown; young apothecia lecideine; medulla not amyloid (I–) **24**

24(23) Thallus thin, ± continuous, pale yellowish, ivory or yellowish green, containing xanthones; all spot test reactions negative; apothecial margin thin, indistinct; exciple narrow, reduced to a few leptodermatous hyphae similar in structure and orientation to the paraphyses (*aethalea*-type); outer exciple cells strongly inflated, carbonized by a brown pigment cap; spores smooth to microrugulate; septum thickening ± persistent; conidia filiform .... ***B. prospersa***

Thallus moderately thickened, continuous, pale beige to pale brown; without xanthones, usually with atranorin and norstictic acid (K+ yellow to orange, forming crystals, P+ yellow), rarely also with gyrophoric acid (C+ pink, fleeting); apothecial margin thick, prominent; exciple broad, not reduced, of mesodermatous interwoven hyphae similar in structure to the hypothecium, outer exciple cells barely inflated, brown pigmentation ± evenly distributed throughout (*leptocline*-type); spores microrugulate to rugulate; septum thickening soon reduced; conidia bacilliform to fusiform ....
.... ***B. subdisciformis*** (Leight.) Vain.

25(22) Hypothecium hyaline; apothecia remaining immersed between areoles, disc ± irregularly deformed by adjoining areoles; with lecanoric acid (C+ fleeting pink, KC+ fleeting pink or C–, KC–); subalpine to alpine, rare, known from San Francisco Peaks and White Mountains (Arizona), Lake Peak and Sierra Blanca Peak, (New Mexico) .... ***B. eganii*** Bungartz

Hypothecium reddish brown; apothecia emergent; disc circular, not deformed; without lecanoric acid (C–, KC–); coastal or more widely distributed montane species **26**

26(25) Thallus pale gray to white, not beige or deep brown; spores distinctly rugulate; with divaricatic acid and biosynthetically related substances...........................
.... ***B. tesserata*** Körb.

Thallus deep brown to olive brown, rarely pale; spores smooth or microrugulate; no divaricatic acid or related substances **27**

27(26) Thallus distinctly areolate, thin to moderately thickened, deep brown to olive brown; with distinct black hypothallus delimiting the thallus and often extending between the areoles, inland .... ***B. tyrolensis***

Thallus rimose to rimose-areolate, thin, not olive, usually deep brown, rarely pale brown; without a hypothallus, coastal and inland **28**

28(27) Premature spores with evenly thickened wall, ± globose, becoming ellipsoid with age; margin prominent, thick, rarely excluded; outer exciple > 20 μm wide in cross section, conidia bacilliform .... ***B. christophii*** Bungartz

Spores of all stages thin-walled, ellipsoid to oblong; lecideine margin thin, usually excluded; outer exciple < 20 μm in cross section; conidia filiform .... ***B. pullata*** Tuck.

29(21) Medulla (at least in parts) amyloid (I+ blue)... **30**

Medulla not amyloid (I–)... **34**

30(29) Medulla K–, KC+ pink and C+ pink (gyrophoric acid), rare .... ***B. uberior*** (**Note**: In the Sonoran region only parasitic material on *Schaereria fuscocinerea* has so far been observed. The species is keyed out here, because non-parasitic type material of *B. malmei* Lynge from Novaya Zemlya (arctic Russia) is anatomically, morphologically and chemically identical and possibly a rare form of *B. uberior* that develops independent thalli.)

Medulla K+ orange to red (orange, needle-shaped crystals), KC– and C–; with norstictic acid **31**

31(30) Young spores with distinct septum thickening, medulla strongly amyloid, even if tested on thallus surface (I+ blackish blue), apothecia remaining immersed, not emerging from thallus, often deformed by adjoining areoles, rarely with a thalline veil; differentiated into distinct, hyaline subhymenium gradually merging into pale to deep reddish brown hypothecium ....
.... ***B. lacteoidea*** de Lesd.

Young spores without septum thickening, medulla amyloid, but reaction obscured if tested on thallus cortex (I+ blue), apothecia immersed to sessile, deformed or not, with or without thalline veil, hypothecium not differentiated from subhymenium, but sometimes hyaline **32**

32(31) Apothecia soon sessile, with thick and prominent lecideine margin; rarely with thalline veil; inner excipular hyphae broad, radiating from deep reddish brown hypothecium, with a narrow, hyaline transition zone and distinctly swollen, pigmented outer exciple cells (*dispersa*-type); conidia > 5 μm long, ± fusiform .... ***Buellia sheardii***

Apothecia immersed to adnate, with thin lecideine margin, young apothecia usually with distinct thalline veil; inner excipular hyphae thin, ± reduced and hyaline, not distinctly radiating from the hypothecium, similar in structure and orientation to the paraphyses, with moderately swollen, pigmented outer exciple cells (*aethalea*-type); conidia < 5 µm long, ± bacilliform **33**

33(32) Thallus with atranorin and norstictic acid; apothecia initially immersed, becoming sessile, circular, not deformed, young apothecia frequently with thalline veil, hypothecium reddish brown throughout; montane, common .... ***B. spuria*** (Schaer.) Anzi

Thallus with norstictic acid only, no other substances; apothecia immersed, not becoming sessile, without thalline veil, often deformed ("comma-shaped"); hypothecium hyaline throughout (at least in all specimens from the Sonoran Region); montane, rare .... ***B. aethalea***

34(29) Apothecia remaining immersed, not emerging, often deformed ("comma-shaped"), rarely circular; all Sonoran specimens with hyaline to pale brown hypothecium; with norstictic acid only, K+ orange to red (orange, needle-shaped crystals); inland .... ***B. aethalea***

Apothecia initially immersed, emerging, not deformed; hypothecium dark reddish brown; norstictic acid absent, K+ yellow (no crystals forming) or K–; coastal **35**

35(34) Thallus white to dark gray, not olive or brown; with atranorin and 2'-*O*-methylperlatolic acid; K+ yellow; young apothecia immersed, but not aspicillioid, becoming adnate to sessile, usually emerging with thalline veil .. .. ***B. stellulata*** (Taylor) Mudd

Thallus brown or olive gray; no secondary metabolites detected; K–; young apothecia immersed, appearing aspicillioid ("bursting through the thallus surface"), becoming adnate to sessile with age, rarely with remains of necrotic material attached to margin (indistinct thalline veil) **36**

36(35) Thallus reddish brown ("leather-colored"), rimose, not delimited by distinct hypothallus, exciple deeply aeruginose, ascospores 10–15 x 6–9 µm; conidia 4–7 µm .... ***B. tergua*** Bungartz

Thallus olive gray to brownish olive, distinctly areolate in the center, with intermediate undifferentiated transition zone along the margin, rising from distinct black, arachnoid hypothallus, exciple fuscous brown, ascospores 9–13 x 4–8 µm; conidia 2-5 µm .... ***B. ryanii*** Bungartz

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MYCOTAXON

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Cumminsiella mirabilissima on *Mahonia aquifolium* in Turkey

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Abstract—*Cumminsiella mirabilissima* on *Mahonia aquifolium* is reported for the first time from Turkey. The morphological features of this fungus are described and illustrated.

Key Words—Rust fungi, *Pucciniaceae,* microscopical features, Anatolian Peninsula

Rust symptoms have been observed on *Mahonia aquifolium* (Pursh) Nutt. growing in the Campus of Kırşehir Arts and Sciences Faculty and Japan Garden (Central Anatolia). The causal agent of this disease has been identified as *Cumminsiella mirabilissima* (Peck) Nannf. [= *Cumminsiella sanguinea* (Peck) Arthur, = *Uropyxis sanguinea* Arthur] (Gäumann 1959; Wilson & Henderson 1966; Kuprevich & Uljanishchev 1975; Ellis & Ellis 1987; Cummins & Hiratsuka 2003). The description drawn up from our Turkish materials. The collections concerned are characterized by the following microscopical features:

Leaf spots bilateral. On the upper surface reddish, on the lower surface brown, minute occasionally. *Spermogonia* epiphyllous and very seldom hypophyllous. *Aecia* hypophyllous, sometimes on petioles and veins, in groups, pale-brown; *aeciospores* angular-globoid or globoid, (17.5–) 22–25 x (15–)17.5–20(–22) μm; wall very finely echinulate, pale-yellow, uniformly 1 μm thick. (Fig. 1 A). *Uredinia* hypophyllous, very rarely epiphyllous, scattered or in small groups, minute, compact, chestnut-brown; *urediniospores* obovoid, almost fusiform or ellipsoid, (27.5–)32.5–35(–38) x (15–)17–20 μm; wall 2–2.5 μm thick, finely warted, yellow gold, with 2 equatorial pores; pedicels colorless, weak, easily broken down. (Fig. 1 B). *Telia* hypophyllous, not very numerous, cushion-shaped, powdered, rarely confluent, chestnut-brown; *teliospores* two celled, ellipsoid or oblong-ellipsoid, rounded at both ends, constricted at the septum, (27.5–)30–35 x 20–22.5 μm; wall 3–5 μm thick, brown-chestnut, of 3 layers: first layer innermost, smooth; second – average, warty; third – outermost, weakly noticeable, cuticularised layer; wall with 2 equatorial pores in each cell; pedicels hyaline, easily broken down with spore from substrate, sometimes oblique attached, swollen at the base, 65–90 x 6–9 μm. (Fig. 1 C).

Autoecious and macrocyclic species.

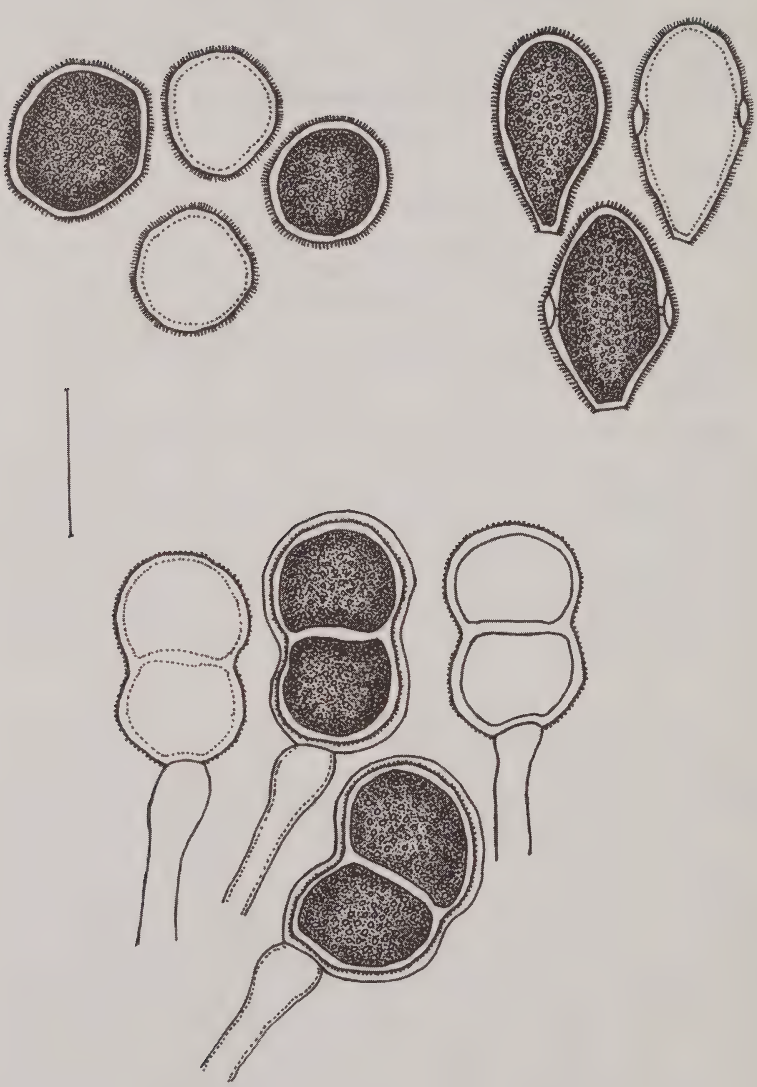

Fig. 1. *Cumminsiella mirabilissima:* A. *Aeciospores;* B. *Urediniospores;* C. *Teliospores.* Scale bar = 20 μm.

Specimens examined: Turkey, Kırşehir Prov., Gölhisar, Petlas, Campus of Gazi University Kırşehir Arts and Sciences Faculty, on *Mahonia aquifolium* (Pursh)Nutt., 39° 4' 53" N, 34° 12' 30" E, 1235 m a.s.l., 17-IV-2002, E.Hüseyin (EH 1141); Kırşehir Prov., Kaman, Çağırkan, Japan Garden, on *Mahonia aquifolium*, 39° 19' 22" N, 33° 43' 12" E, 1400 m a.s.l., 20-IX-2002, E.Hüseyin (EH 1142).

The specimens are deposited in the Herbarium of the Gazi University, Kırşehir Arts and Sciences Faculty, Kırşehir, Turkey.

Cumminsiella mirabilissima is known on *Mahonia aquifolium* from Europe (Wilson & Henderson 1966; Kuprevich & Uljanishchev 1975; Denchev 1995), Central and North America (Farr & al. 1995).

Before our investigations 290 species from 13 genera of rust fungi were reported from Turkey (Tamer & al. 1998; Kirbag, Civelek & Huseyinov 2001; Huseyin & Kirbag 2003). There are no records of the genus *Cumminsiella* Arthur in these publications. This is the first report of genus *Cumminsiella* and *C. mirabilissima* from Turkey.

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Interesting taxa of *Meliolaceae* in HMAS, China

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Abstract—This paper gives an account of five meliolaceous fungi in the Herbarium Mycologicum Instituti Microbiologici, Academiae Siniae (HMAS), China. Of these, *Appendiculella malaisiae* and *Meliola sawadae* are described and illustrated as new species.

Key words—*Capparaceae, Meliolales, Moraceae*

Appendiculella malaisiae B. Song, *sp. nov.* **Fig. 1**

Similis Appendiculella tonkinensis et A. tonkinensis var. cecropiae sed differt appressoriis brevioribus et ascosporis brevioribus et latis.

Etymology: *malaisiae,* in reference to the host species, *Malaisia scandens.*

Colonies amphigenous, black, nearly velvety, scattered, up to 6 mm in diameter, rarely confluent. Hyphae brown, nearly straight, alternately branching, closely reticulate, cells mostly 25–45 *x* 6-8 μm. Appressoria in alternate or unilateral arrangement, spreading, nearly straight or bent, 22–37 μm long; stalk cells cuneate to cylindrical, 7.5–22 μm long; head cells nearly ellipsoid, entire or nearly lobate, 15–17 *x* 13–15 μm. Phialides mixed with appressoria, opposite or alternate, scattered, ampulliform, 20–28 *x* 5.5–7.5 μm. Mycelial setae absent. Perithecia scattered or nearly aggregate, black, globose, verrucose, up to 220 μm in diameter, larviform appendages mostly 6-9, brown, transversely striate, conoid to mammillate, attenuate upwards, obtuse to nearly acute at apex, straight to slightly curved, projecting up to 20–45 μm, 20–35 μm broad at base. Ascospores brown, cylindrical, obtuse or nearly acute at ends, 4–septate, constricted at septum, 43–45 *x* 12–13 μm.

Holotype: *On leaves of Malaisia scandens (Lour.) Pl. (Moraceae). Lianchang County, Zhanxian, Hainan Province, China. August 8, 1956, G.Z. Jiang, HMAS 20689.*

So far, four taxa of *Appendiculella* occuring on members of the family Moraceae, namely *Appendiculella echinus* (Henn.) Höhn., *A. echinus* var. *domingensis* Hansf., *A. tonkinensis* (P. Karst. & Roum.) Toro, and *A. tonkinensis* var. *cecropiae* (F. Stevens) Hansf. have been found from Brazil, Guiana, Panama, San Domingo, and the Asian tropical region (Toro 1927; Hansford 1961). The main distinguishing characters of *A.*

echinus and *A. echinus* var. *domingensis* are that their ascospores are all wider (15-18 µm for *A. echinus* and 17–18 µm for the variety), their larviform appendages are also longer (up to 180 µm for *A. echinus* and 80 µm for the variety); and of *A. tonkinensis* and *A. tonkinensis* var. *cecropiae* are that their appressoria are shorter (14–22 µm for *A. tonkinensis*, 13-20 µm for the variety), their ascospores are shorter and broader (37–43 *x* 15-16 µm for *A. tonkinensis*, 32–35 *x* 14–15 µm for the variety); in addition, the ascospores of *A. tonkinensis* are fusoid, allowing easy distinction from the new species.

This is the first record of the genus *Appendiculella* parasitic on the genus *Malaisia*.

Armatella longispora W. Yamam., Sci. Rep. Hyogo Univ. Agr. Ser Agr. Biol. 3:19. 1957

On leaves of *Cinnamomum comphora* Sieb.(*Lauraceae*). Tianjin River, Sichuan Province, China. September 29, 1956, HMAS 20688.

This species was recorded from Taiwan, Guangdong, and Anhui in China (Hu et al. 1996).

Asteridiella malloticola (W. Yamam.) Hansf., Sydowia 10:49. 1956

On leaves of *Mallotus apelta* (Lour.) Muell.-Arg. (*Euphorbiaceae*). Xinglong, Hainan Province, China. July 3, 1956, S. J. Han, HMAS 33462.

This species was recorded from Taiwan, Guangdong, and Yunnan in China, and is also distributed in India and the Philippines.

Meliola champereiae Syd. & P. Syd., Ann. Mycol. 12:540. 1914

On leaves of *Champereia manillana* Merr. (*Opiliaceae*). Chishui,Taizhong, Taiwan Province, China. November 29, 1928, K. Sawada, HMAS 05100.

This species was recorded from Taiwan in China, and is also distributed in the Philippines (Hu et al. 1999).

Meliola sawadae B. Song, *sp. nov.* **Fig. 2**

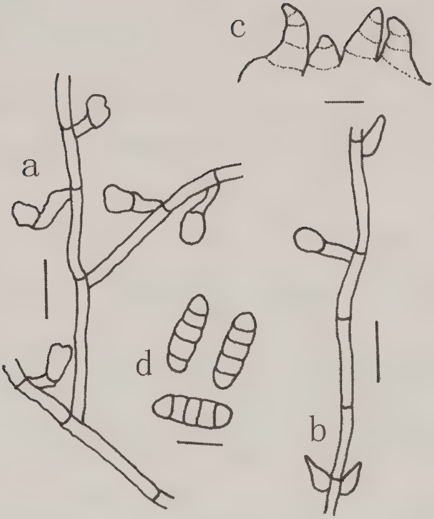
Similis Meliola balakrishnanii, M. capparidicola et M. capparidis sed differt ascosporis grandioribus.

Etymology: *this species is named in honour of the Kaneyoshi Sawada, collector of the type, a mycologist of Japan, for his outstanding contributions to study on the fungi.*

Colonies amphigenous, mostly hypophyllous, black, velvety, scattered, up to 4 mm in diameter, rarely confluent. Hyphae brown, nearly straight, oppositely branching, closely reticulate, cells mostly 20–35 *x* 7–8.5 µm. Appressoria in opposite or alternate arrangement, spreading, straight or bent, 17-25 µm long; stalk cells cuneate to cylindrical, 2.5-6 µm long; head cells nearly oblong, entire, 12–20 *x* 7.8–11 µm. Phialides mixed with appressoria, opposite or alternate, scattered, ampulliform, 16–21 *x* 6.5–8.2 µm. Mycelial setae scattered, black, simple, straight to slightly curved, acute or sometime obtuse at apex, up to 300 µm long, 7.5–8.9 µm broad at base. Perithecia aggregate, black, globose, verrucose, up to 160 µm in diameter. Ascospores brown, nearly ellipsoid or oblong, obtuse or nearly acute at ends, 4-septate, constricted at septum, 25–30 *x* 10–13 µm.

Holotype: *On leaves of Capparis kikuchii Hay.(Capparaceae). Taidong, Taiwan Province, China. April 27, 1909, K. Sawada, HMAS 05098.*

1



2

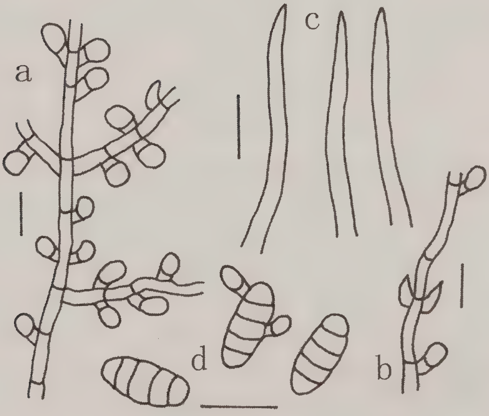


Fig.1 *Appendiculella malaisiae* (a. hyphae with appressoria; b. hyphae with appressoria and phialides; c. larviform appendages; d. ascospores) (Bars=25 μm).

Fig.2 *Meliola sawadae* (a. b. hyphae with appressoria and phialides; c. mycelial setae; d. ascospores and germinating ascospore) (Bars=25 μm).

Four species of the *Meliola* on the family *Capparidaceae*, namely *Meliola balakrishnanii* L. N. Nair & V. P. Kaul, *M. capparidicola* Hosag., *M. capparidis* Hansf. and *M. stixis* B. Song & T. H. Li have been found in India, Uganda and China (Hansford 1961; Hosagoudar et al. 1997; Song et al. 2002). The new species differs the *M. balakrishnanii*, *M. capparidicola* and *M. capparidis*, which have larger ascospores (34–50 μm long and 13–20 μm wide). In addition, the appressoria of *M. stixis* are shorter (11–17 μm) and the head cells are nearly globose or ovate (9–12.5 *x* 8.2–10.8 μm), and the mycelial setae of *M. capparidis* are dentate, distinguishing these from the new species.

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Hu YX, Song B, OuyangYS, Jiang GZ. 1999. *Meliolales* II. Flora Fung. Sin. 11:1-252 (in Chinese)

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Molecular analyses confirm the relationship between *Stephanospora caroticolor* and *Lindtneria trachyspora*

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Abstract—The relationship between *Lindtneria trachyspora,* with resupinoid basidiomes, and *Stephanospora caroticolor,* with sequestrate basidiomes, is discussed. Analyses of the ITS1, ITS2 and 5.8 S ribosomal DNA sequences confirm the morphological and chemical affinities established by early authors.

Key words—*Stereales, Russulales, Stephanosporaceae*, *Lindtneriaceae*, rDNA

Introduction

The taxa included in the family *Stephanosporaceae* Oberw. & E. Horak show sequestrate habit. According to Kirk et al. (2001) and following Hibbett & Thorn (2001), this family is one of the 11 considered in the order *Russulales* Kreisel ex P.M. Kirk, P.F. Cannon & J.C. David. The only species of this family in the Northern hemisphere, *Stephanospora caroticolor* (Berk.) Pat. (Pegler et al. 1993), is very easy to recognize by the bright orange basidiome, the evanescent peridium and the characteristic spores with a peri-appendicular corona.

In the family *Corticiaceae* Herter, all the taxa have a resupinate basidiome and are included in the order *Polyporales*. In agreement with Hjortstam (1987), Kirk et al. (2001) include the species of the genus *Lindtneria* Pilát in this family. During the last year, we have studied different collections of *Lindtneria trachyspora* (Bourdot & Galzin) Pilát and *Stephanospora caroticolor*. Both taxa show the same basidiome colour and the spores have the same morphology. Based on microscopic and ultrastructural characters of both taxa (e.g. strongly sculptured spores), Oberwinkler & Horak (1979) proposed to include *Lindtneria* Pilát and *Stephanospora* Pat. in the same family (*Stephanosporaceae* Oberwinkler & Horak). The close relationship between both genera was also accepted in Jülich (1981), but he proposed the monogeneric family *Lindtneriaceae* Jülich.

The main purpose of this study was to know if molecular data support the hypothesis that *L. trachyspora* and *S. caroticolor* are closely related species.

Material and Methods

MATERIAL EXAMINED—All material is deposited in the herbarium of the Real Jardín Botánico (Madrid, Spain). *Lindtneria trachyspora.-* Germany, Bavaria, Oberbayern, district Bad Tölz-Wolfratshausen, in the valley of the river Isar between Vorderriß and Wallgau, on decayed wood lying on the riverbank, 47 33´north and 11 24´west, 795 m elev., 1/X/1997, leg. et det. S. Raidl (SR413, MA-Fungi 47773); *idem,* 19/X/1998 (SR702, MA-Fungi 47774); *idem*, 22/X/1999 (SR907, MA-Fungi 47775). *Stephanospora caroticolor:* Germany, Bavaria, Oberbayern, district Bad Tölz-Wolfratshausen mixed forest near the Pupplinger Au near Wolfratshausen, 10/X/1999, leg. Prof. W. Steglich (MA-Fungi 47684).

MOLECULAR METHODS—A small quantity (less that 10 mg) of each collection was subjected to molecular analysis of the internal transcribed spacer regions of rDNA (ITS1 and ITS2), including the 5.8S. Total DNA was isolated using E.Z.N.A. Fungal MiniPrep Kit (Omega-Biotech, Doraville, USA) as described in Martín & García-Figueres (1999). Primer pair ITS1F and ITS4 was used to obtain amplifications of both ITS regions, including the 5.8S of the ribosomal RNA gene cluster and small flanking parts of the SSU and LSU genes; primers were described in White et al. (1990). Amplifications were done using Ready-to-Go® PCR Beads (Amersham-Biosciences, UK) as mentioned in Winka et al. (1998). Results of amplifications were assayed from 5µl aliquots by gel electrophoresis of 2% Pronadisa D-1 Agarose (Lab. Conda, Spain). Amplification products were cleaned using the E.Z.N.A. Clean kit (Omega Biotech, USA) and both strands were sequenced separately using primers ITS1F and ITS4 at the Authomatic Sequencing Service (CIB-CSIC, Madrid). Sequence Navigator ™ Sequence Comparison software (Perkin Elmer, USA) was used to identify the consensus sequence from the two strands of each ITS region. The new sequences have been logged in the EMBL database with the Accession Numbers AJ419224 (*Stephanospora caroticolor* MA-Fungi 47686) and AJ419225 (*Lindtneria trachyspora* MA-Fungi 47774). SEQAPP software for multiple sequences was used to compare these sequences. Alignment gaps were marked.

Results and Discussion

MORPHOLOGY—As shown in Fig. 1, the spores in both taxa are globose, spinulose with peri-appendicular corona. *Lindtneria trachyspora* is the only species of this genus in Europe with globose and spinulose spores. Spores of the other two species mentioned in Ryvarden & Gilbertson (1993), *L. leucobryophila* (Henn.) Jülich and *L. flava* Parm., are ellipsoid and warted. Hjortstam (1987) included in his key, a species, *L. pterospora* Reid, with globose spores, but prominent wing-like crests. Oberwinkler & Horak (1979) consider that from the microscopic and ultrastructural point of view *Lindtneria trachyspora* and *Stephanospora caroticolor* are practically indistinguishable.

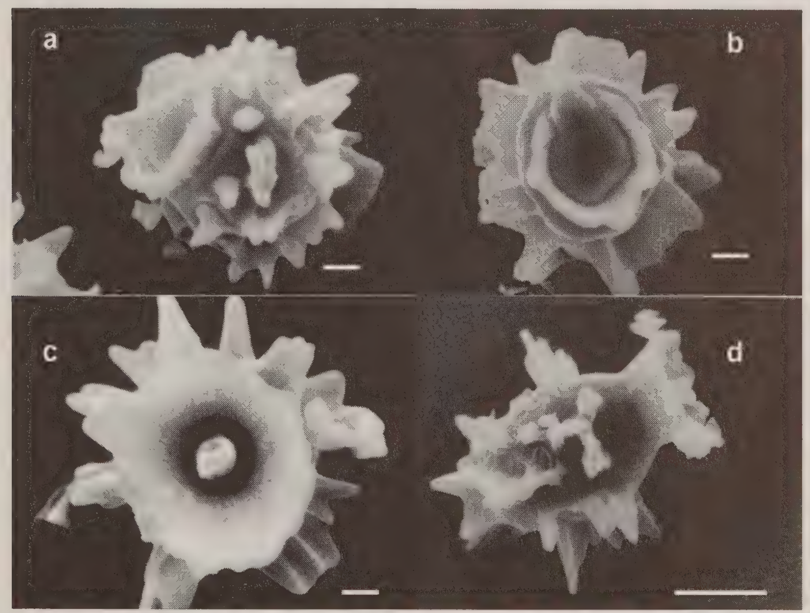

Fig. 1 Spores: a) *Lindtneria trachyspora* MA-Fungi 47773; b) *L. trachyspora* MA-Fungi 47774; c) *L. trachyspora* MA-Fungi 47775; d) *Stephanospora caroticolor* MA-Fungi 47686. (Bar figs 1-3= 1 μm; Bar fig. 4= 5 μm).

MOLECULAR ANALYSIS—The total aligned sequences ITS1-1 and ITS-2, including the 5.8S nrDNA, were 739 base pairs (bp) long, without ambiguous areas (Fig.2). The nucleotide differences among all pairwise comparisons was 37 bp in ITS1 and 31 in ITS2; there were not differences in the 5.8S rDNA gene. In ITS1 15 differences are due to deletions, 16 to transitions and 6 to transversions. In ITS2 the differences are quite similar: 16 deletions, 10 transitions and 5 transversions.

Recently, Steglich and collaborators from the Department Chemie der Universität München (Munich, Germany) have identified and isolated two pigments that give the bright orange colour to the peridium and gleba of *Stephanospora caroticolor* (Hellwig 1999, Lang et al. 2001): stephanosporin (young basidiomes) and 2-chloro-4-nitrophenol (mature basidiomes). From the methanol extractions other compounds were identified: 4-hydroxy-acetanilide (paracetamol), 4-amino-2-chlorophenol and 4-nitrophenol. These authors have found 4-nitrophenol and traces of 2-chloro-4-nitrophenol in the resupinate basidiomes of *Lindtneria trachyspora*. The oxidative transformation of stephanosporin into 2-chloro-4-nitrophenol (fungicide) is a complex enzymatic process. In agreement with Lang et al. (2001), the presence of this compound in *L. trachyspora* and *S. caroticolor* supports the inclusion of both taxa into the same family by Oberwinkler & Horak (1979). The ITS rDNA is highly variable in fungi, even among closely related taxa. Kretzer & Bruns (1997) investigated the secotioid genus *Gastrosuillus* Thiers to clarify its relationships with *Suillus* Mich. ex Gray. The phylogenetic analysis of the unambiguous sites of the alignment allowed them to transfer all known *Gastrosuillus* species to *Suillus*. Ko, Hong & Jung (1997) found that the sequences obtained from eight species of *Trichaptum* Murrill were very variable (e.g. from the 460 ITS1 positions, only 101 were optimally aligned). The alignment among our isolates has no unambiguous parts, and the sequences dissimilarities are not very high (ITS1: 37 positions: ITS2: 31 positions). However, more studies including chemical and molecular methods should be done in the other species of *Lindtneria* and *Stephanospora* to conclude that both genera belong to the same family.

The linkages between sequestrate fungi and epigeal basidiomycetes have been reported many times in the literature (Malençon 1931, Singer 1975). Molecular analyses, mainly from rDNA, give additional evidence of relationship between agarioid/boletoid and sequestrate fungi

(Hibbett et al. 1997). In particular, in the order *Boletales* (Bruns et al. 1989, Baura et al. 1992, Kretzer et al. 1996, Kretzer & Bruns 1997, Johanesson & Martín 1999), *Cortinariales* (Martín & Rocabruna 1999, Martín & Moreno 2001) and *Russulales* (Martín et al. 1999, Calonge & Martín 2000, Miller et al. 2001) these affinities have been established.

In our previous studies in *Cortinariales* (Martín & Rocabruna 1999, Martín & Moreno, 2001) based on morphological, ecological and molecular data, we conclude that the agaricoid basidiomes of *Setchelliogaster rheophyllus* (Bertault & Malençon) Malençon & Moreno (= *Naucoria rheophylla* Bertault & Malençon) and the gasteroid basidiomes of *Setchelliogaster tenuipes* (Setchell) Pouzar (=*Secotium tenuipes* Setchell) are two morphotypes of the same species. Köljalg et al. (1998) in their database of complete ITS and part of the LSU DNA included more than 40 tomentelloid and thelephoric species: parsimony and distance analyses confirmed that a *Tomentella radiosa* (P. Karst.) Rick with a resupinoid basidiome is the same species as *Thelephora terrestris* Ehrh.: Fr.

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```
         *       *  *** *
TRALIN_2  CATTATCGAATCGTTGAAAC TTGGCTGTCGCTGGCTTTCT CCTTCCTGGGGATCGCATGT
CARSTE_1  CATTATCGAATCGTTAAAAC TTGGCTGTCGCTGGCTCTCT CCTTCTCGAG-ATTGCATGT

                ** !!                *                                !
TRALIN_2  GCACGCCCATGTTCAAACTT TTCATTTTAACCTCCTGTGC ACTTTTGTGGATCGTGGATG
CARSTE_1  GCACGCTTAGTTTCAAACTT TTCATTCTAACCTCCTGTGC ACTTTTGTGGATCGTGGAAG

                                                    !                  !
TRALIN_2  GATAACACTT-GTCAAAGTA ACATTTGGTTTTGGGGATCG AGAGTCTGCTTTCCCCTACT
CARSTE_1  GATAA-ACTTTGTCAAAGTA ACATTTGGTTTTGGGGATCG C-AGTCTGCTTTCCCCTACA

                    * *                                  *          *
TRALIN_2  ATTTGTCCA-CGGTTCATGT CTTTTTA-CTA--CAAACCA TTAAACAAAAA----CCTAG
CARSTE_1  ATTTGTCCAATGATTCATGT CTTTTTAACTATACAAACCA TTAAATAAAAAATAACTTAG

              *  !  *                                 !*
TRALIN_2  AATGTTTAACGAGTTGGGGA CTTTAGTGACCCTCTCTTAA AAATTTATACAACTTTCAAC
CARSTE_1  AATGCTTTACAAGTTGGG-A CTTTAGTGACCCT-TCTTAA AATCTTATACAACTTTCAAC

TRALIN_2  AACGGATCTCTTGGCTCTCG CATCGATGAAGAACGCAGCG AAATGCGATAAGTAATGTGA
CARSTE_1  AACGGATCTCTTGGCTCTCG CATCGATGAAGAACGCAGCG AAATGCGATAAGTAATGTGA

TRALIN_2  ATTGCAGATTTCAGTGAATC ATCGAATCTTTGAACGCACC TTGCACCCTGTGGTATTCCA
CARSTE_1  ATTGCAGATTTCAGTGAATC ATCGAATCTTTGAACGCACC TTGCACCCTGTGGTATTCCA

                                       !
TRALIN_2  CAGGGTATGCCCGTTTGAGT ATCATTAATTCATCAACTCC AAAACCTTTGTGTTCTTGGT
CARSTE_1  CAGGGTATGCCCGTTTGAGT ATCATTAAGTCATCAACTCC AAAACCTTTGTGTTCTTGGT

           *                               * *   *
TRALIN_2  GTTTGGTCT--GAGGGTCAT TGCAGGCTCTTTGTAAAGCC -GGCTCCCTTTAAATCCATT
CARSTE_1  GCTTGGTCTTTGAGGGTCAT TGCAGGCTCTTTATGA-GTC AGGCTCCCTTTAAATCCATT

                 *                 !      *                  *        !
TRALIN_2  AGCGAGATTTCCCTGTGCTG AACTAGTCTCTCGACGTGAT AGTCTATCTGCGTCAAATGT
CARSTE_1  AGCGAGACTTCCCTGTGCTG AACTTGTCTCTTGACGTGAT AGTCTATCTACGTCAAATTT

          !                       !                            !
TRALIN_2  AGAGTTCTCGTTGGGCTTGC TTCAAATCCGTCCTCTTTGG ACAATCGGAATAAGAGTTGC
CARSTE_1  TGAGTTCTCGTTGGGCTTGC TTCTAATC-GTCCTCTTTGG ACAATCGGAATTAGAGT-GC

           *         *                * !
TRALIN_2  ACATATCTGTGTGCATCCCT CTTTCCAGAACCATTTTGAT CTCAAATCGGGTAGGACTAC
CARSTE_1  ATATAT----GCG---CCCT -TTTC-AAATCCATTTTGAT CTCAAATCGGGTAGGACTAC

TRALIN_2  CCGCTGAACTTAAGCATAT
CARSTE_1  CCGCTGAACTTAAGCATAT
```

Fig. 2 Alignment of the ITS1 and ITS2 sequences, including the 5.8 S rDNA of *Lindtneria trachyspora* (TRALIN-2, AJ419225) and *Stephanospora caroticolor* (CARSTE-1, AJ419224) (*: transitions; !: transversions).

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A new *Neotyphodium* species symbiotic with drunken horse grass *(Achnatherum inebrians)* in China

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Abstract—A new endophytic fungus has been isolated from *Achnatherum inebrians* collected from Gansu Province, China. The morphological and cultural characters are used to describe the new species, *Neotyphodium gansuense*.

Key Words—taxonomy, new taxon, alkaloids

Introduction

Drunken horse grass (*Achnatherum inebrians* (Hence) Keng) is a perennial bunchgrass, which is so named because it is associated with narcosis of horses grazing on pasture containing the grass. *A. inebrians* is mainly distributed on alpine and subalpine grasslands in Gansu, Xinjiang, Qinghai, Tibet and Inner Mongolia, China (Shi 1997). An endophytic fungus has been found in seeds, leaf sheaths and peduncles of the grass (Bruehl et al. 1994; Miles et al. 1996; Li et al. 1997, 1998; Nan & Li, 2000; Li et al. 2004). Two major ergot alkaloids, ergonovine and lysergic acid amide, have been detected from endophyte infected *A. inebrians* (Miles et al. 1996). Although these alkaloids are known to be toxic to grazing animals (sheep, goats and cattle), the link between endophyte infection in *A. inebrians* and narcosis of grazing animals in China has still to be proved experimentally. The endophyte we obtained from *A. inebrians* differs in several aspects from species already described and we therefore propose it as a new taxon.

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Materials and methods

Endophytes were isolated from pieces (5 mm long) of single tillers of *A. inebrians* placed on potato dextrose agar (PDA), as described by Dapprich *et al.* (1996). During incubation, the pieces of tiller tissue were examined periodically with a dissecting microscope (Leica MS5) for the emergence of mycelium. Contaminant fast growing fungi were discarded and uncontaminated pieces of tissue were transferred onto fresh plates of PDA until slow growing fungi appeared from the cut ends of the host tissue pieces. These colonies were later transferred onto fresh plates of PDA as pure cultures.

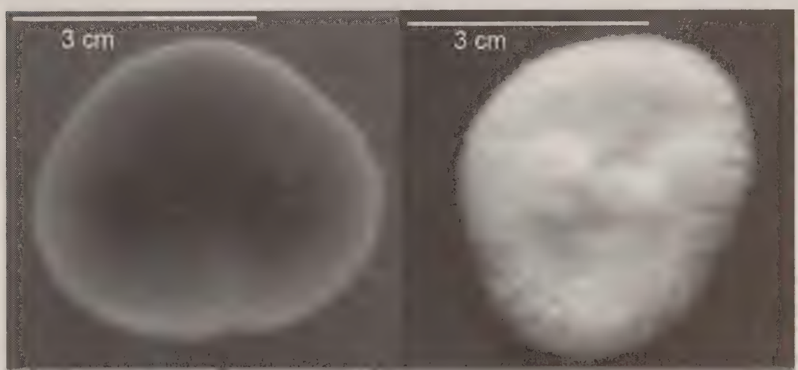
Colony diameters were measured and morphological characteristics were observed weekly. Colonies produced abundant conidia under stress conditions in the medium. Therefore, the central part (c. 1 cm in diameter) of the medium was removed and discarded to promote sporulation from the cut edge of the colony. Fifteen isolates of the fungus were obtained in total. For each isolate, 20 measurements of hyphae, conidiophores, conidia and chlamydospores were made with a light microscope (Leica DMRB).

Taxonomy description

Neotyphodium gansuense C.J. Li et Z.B. Nan *sp. nov.* **Plate 1, 2**

> Coloniae albae, gossypinae, lente crescents, 30 mm diametro aetate 28 dierum ad 22 C in PDA; reverso pallide brunneo vel brunneo. Odor nullus. Hyphae vegetativae hyalinae, septatae, 1.3-2.5 μm latae. Cellae conidiogenae ex hyphis aeriis oriuudae, discretae, solitariae, orthotropicae, determinatae, 7.5-18.8 (med. 13.6) μm longae, 1.3-2.5 μm latae ad basim, 0.8-1.3 μm latae ad apicem. Conidia solitariae, subglobosae, ellipsoidea, semiglobularea, reniformia, hyalina, saepe transversaliter affixa, 3.8-5 X 2.5-3.8 μm. Chlamydosporae globosae vel subglobosae, hyalinae, laterales vel intercalares, 5-10 X 5-8 μm. Telemorphosis ignota.
>
> In culturis ex culmis *Achnatheri inebrians*, in Sunanensi, Gansuensi, Sinico, C. J. Li, Sept. 2002, MHLZU-GS0201, holotypus hic designatus.

Colonies on PDA slow growing, reaching 30 mm diameter in 4 weeks at 22 C, forming a compact, centrally raised, white cottony mass of aerial hyphae. Colony reverse pigmented with pale brown to dark brown central area; fracturing of agar occurs. Odour is absent. Vegetative hyphae hyaline, septate, convoluted, coiled, sinuous, 1.3-2.5 μm wide, in intercellular leaf sheath, pith of peduncle and innermost seed coat. Conidiogenous cell very sparse on PDA, arising solitarily from aerial hyphae, discrete, orthotropic, unbranched, hyaline, sometimes with a basal septum, 7.5-18.8 (mean 13.6) μm long, and gradually tapering from 1.3-2.5 μm wide at the base to 0.8-1.3 μm at the tip. Sporulation is rare on PDA unless the colony is stressed. Conidia solitary, subspherical, short ellipsoid, semiglobular, hyaline, smooth-walled, 3.8-5 x 2.5-3.8 μm, often attached transversely across the conidiogenous cell at the apex. Chlamydospores terminal or intercalary in chains, hyaline, smooth-walled, spherical to subspherical, 5-10 x 5-8 μm. Teleomorph unknown.



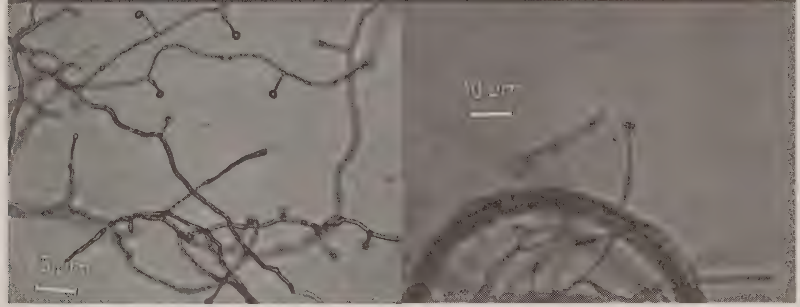


Plate 1 *(top)*. Reverse (*left*) and upper (*right*) view of *N. gansuense* on PDA after six-weeks inoculation at 22 C under continuous dark.

Plate 2 *(bottom)*. Conidiophores and conidia of *N. gansuense* on PDA under a light microscope. *Left:* Unstained with green filter; *Right:* Stained with 0.8% aniline blue.

Isolated from culms and leaf sheaths of plants grown from seeds of *A. inebrians* originally collected from a deer farm in Sunan County, Gansu Province, China in September 2002 by C.J. Li, deposited in Mycological Herbarium of Lanzhou University, China. (MHLZU-GS0201).

Etymology – the endophyte is named after the Gansu Province of China where the host plant is common.

Discussion

Since the establishment of the genus *Neotyphodium* as anamorphs of *Epichloë* and related asexual grass endophytes (Glenn et al. 1996), 14 species have been formally named and one other species tentatively identified (Table 1). *N. gansuense* can be distinguished from these 15 species by differences in the characteristics shown in Table 1. The growth rate of *N. gansuense* (diam. 7.5 mm/week) separates it from the relatively slow growing species (diam. < 4 mm/week) of *N. lolii, N. coenophialum, N. uncinatum, N. aotearoae, N. australiense, N. melicicola, N. chisosum* and *N. occultans* and from the relatively fast growing species (diam. 10 mm/week) of *N. typhinum* and *N. chilense*. *N. gansuense* can be separated from species with a similar growth rate by other characteristics (Table 1). *N. gansuense* has a different colony appearance to *N. huerfanum* and shorter conidiogenous cell and smaller conidia than *N. tembladerae, N. siegelii* and *N. starrii*. In addition, *N. gansuense* differs from *N. starrii* in not having an aculeate conidiogenous cell.

Some *Neotyphodium* species have been isolated from more than one species of host plant, e.g.: *N. tembladerae* in *Festuca argentina, F. hieronymi* and *Poa huecu* (Cabral et al. 1999) and *N. occultans* in *Lolium canariense, L. multiflorum, L. persicum, L. remotum, L. rigidum, L. subulatum* and *L. temulentum* (Moon et al. 2000). Also, some grass species are host for more than one species of *Neotyphodium*, e.g.: *N. aotearoae* and *N. australiense* in *Echinopogon ovatus* (Moon et al. 2002) and *N. uncinatum* and *N. siegelii* in *L. pratense* (Gams et al. 1990; Craven et al. 2001). A second, unidentified endophyte has been isolated from *A. inebrians* originally collected from Xinjiang, China (Bruehl et al. 1994). This endophyte grew slowly, with a paucity of aerial mycelium, forming compact creamy-white to creamy-buff colonies that did not sporulate on PDA or cornmeal agar (CMA) and did not sporulate on PDA or cornmeal agar (CMA) (Bruehl et al. 1994; Miles et al. 1996). It was associated with production of the alkaloids of ergonovine and lysergic acid amide in endophyte-infected *A. inebrians* (Miles et al. 1996). Bruehl et al. (1994) and Moon et al. (2000) suggested that it could be a new species of *Neotyphodium*.

Based on the life cycle categories for *Neotyphodium*-grass associations proposed by White et al. (1993), *N. gansuense* belongs to type III species (sexual stromata not found). Schardl and co-investigators defined morphological, biological and phylogenetic species and identified new species that were the result of apparent hybridization between species of *Epichloë* (Schardl et al. 1994; Moon et al. 2000, 2002; Craven et al. 2001; Schardl & Craven 2003).

Table 1. Comparison of described *Neotyphodium* species

Species (Host)	Growth rate (mm/week)	Colony	Conidiogenous cell (μ)	Conidia (μ)	Literature cited
N. aotearoae (*Echinopogon ovatus*)	<2.2 on PDA at 22C	Tan to brown, raised	Not found	Not found	Moon et al. 2002
N. australiense (*E. ovatus*)	<3.7 on PDA at 22C	Off-white to light tan, rings, raised	Nonseptate, 11-25 x 2	Ellipsoid to lunate 5-7 x 3-4	Moon et al. 2002
N. chilense (*Dactylis glomerata*)	10 on 4% Glucose Agar at 25C	White, cottony,	Nonseptate, 10-30(50) x 1-1.5	Oblong, 3-6 x 1-2	Morgan-J et al. 1990
N. chisosum (*Stipa eminens*)	1.8 PDA at 20C	White, cottony, pulvinate	Septate, 10-30x2-5	Ellipsoid to obovate, 5-9 x 2.5-4	White & Morgan-J 1987a
N. coenophialum (*F. arundinacea*)	2 on PDA at 20C	White felty or cottony	Nonseptate, 12-34 x 1.5-2	Subulate to falcate, 7-11 x 2-3	Morgan & Gams 1982
N. huerfanum (*F. arizonica*)	7 on PDA at 22C	White to yellowish-green, orange, zonate	Septate, 13-25 x 1.5-3	Cylindrical to lunate, 3-4 x 2-2.5	White et al. 1987
N. lolii (*Lolium perenne*)	1.6 on PDA at 20C	Slightly off-white, waxy	Nonseptate, 13.5-65 x 1.5-2	ellipsoid to reniform, 4.7-7 x 1.9-2.5	Latch et al. 1984
N. melicicola (*Melica acemosa*)	<3.7 on PDA at 22C	White, felty, convoluted	Septate, 6-35 x 2.5	Ellipsoid to lunate, 5-8 x 3.5-5	Moon et al. 2002
N. occultans (*L. multiflorum*)	0.6 on PDA at 22C	Off-white to tan, raised	Not found	Not found	Moon et al. 2000
N. siegelii (*L. pretense*)	3.7 on PDA at 24C	White, cottony	Nonseptate, 12-24 x 1.5-3	Navicular to reniform 6-8 x 2.5-3.5	Craven et al. 2001
N. starrii (*F. subulata*)	5 on PDA at 22C	White or slightly tan	Septate, 15-31 x 1.5-2.5	Allantoid, reniform 4-7 x 1.5-3	White & Morgan-J 1987b
N. tembladerae (*F. argentina*)	<7 on PDA at 24C	White, cottony to lanose, elevated to appressed	Septate, 10-31 x 1.5-3.5	Lunate, reniform, 4-10 x 2-4	Cabral et al. 1999
N. typhinum (*Holcus mollis*)	10 on MEA at 20C	White, cottony, tufted	Septate, 14-35 x 1.5-2	Fusiform, lunate, 4.5-8.5 x 2-3	Morgan& Gams 1982
N. uncinatum (*F. pratensis*)	<3 on PDA at 25C	Whitish to rosy buff, raised	Nonseptate, 9-18(25) x 1.5-2	Uncinate 5-13 x 1-2	Gams et al. 1990
N. inebrians (*Achnatherum inebrians*)	0.5 on PDA at 20C	Cream-buff, raised	Not found	Not found	Breuhl et al.1994; Miles et al. 1996
N. gansuense (*A. inebrians*)	7.5 on PDA at 22 C	White, cottony, raised	Septate, 7.5-18.8 x 1.3-2.5 (13.61 x 4.69)	Subspherical, semiglobular, 3.8-5 x 2.5-3.8	Li, Nan et al..

Further work is required to determine whether *N. gansuense* can infect other plant species and molecular phylogenetic work is needed to evaluate the potential hybrid origin of the genome.

Acknowledgements

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MYCOTAXON

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Kuehneola uredinis (Uredinales) on species of *Rubus* in Turkey

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Abstract— *Kuehneola uredinis* on *Rubus canescens* and *R. caesius* is reported, described, and illustrated for the first time from Turkey.

Key words—*Phragmidiaceae,* microscopical features, morphology, Anatolian Peninsula

Severe disease symptoms have been observed on *Rubus canescens* DC. and *R. caesius* L. growing in the forests of Ege region and Black Sea coast of Anatolian Peninsula. First symptoms appeared at the end of May and the beginning of June and formed as reddish and then pale yellow, pale golden-yellow spots. The causal agent of this disease has been identified as *Kuehneola uredinis* (Link) Arthur [= *Chrysomyxa albida* J.G.Kühn; = *Kuehneola albida* (J.G.Kühn) Magnus] (Gäumann 1959; Wilson & Henderson 1966; Kuprevich & Ulijanizshev 1975; Ellis & Ellis 1987; Cummins & Hiratsuka 2003). The collections concerned are characterized by the following microscopical features:

Spermogonia epiphyllous, subcuticular, gregarious, spheric-depressed, hemispheric, 75–90 μm wide, 35–40 μm high. *Aecia* epiphyllous, subepidermal, roundly, orange-yellow; *aeciospores* globoid, ellipsoid, ovoid, 20–22.5 x (17.5–)18–20 μm; wall colorless 2–2.5 μm thick, dense minute-verrucose (Figure 1 A). *Uredinia* hypophyllous, sometimes on the petioles or caulicolous, scattered, pulverulent, orange-yellow, without paraphyses; *urediniospores* globoid, subellipsoid, (19–)20–23(–27) x 17.5–20 μm; wall pale-yellow, sometimes colorless, 1.5–2 μm thick, dense verrucose or short-thorned; germ pores indistinct, probably 3–4, equatorial (Figure 1 B). *Telia* hypophyllous, scattered, yellowish-whitish; *teliospores* cylindrical, rounded-truncate, often trapezoidal, 18–32.5 x 17.5–25 μm, articulate-dense jointed to clavate or elongate chains, each of 5–13 superposed spores, like multicellular spore; wall colorless or light-yellow, smut, with one germ pore in each spore, 1.5–2 μm thick, to 4 μm thick on apical; pedicel is short and fragile (Figure 1 C).

Autoecious and macrocyclic species.

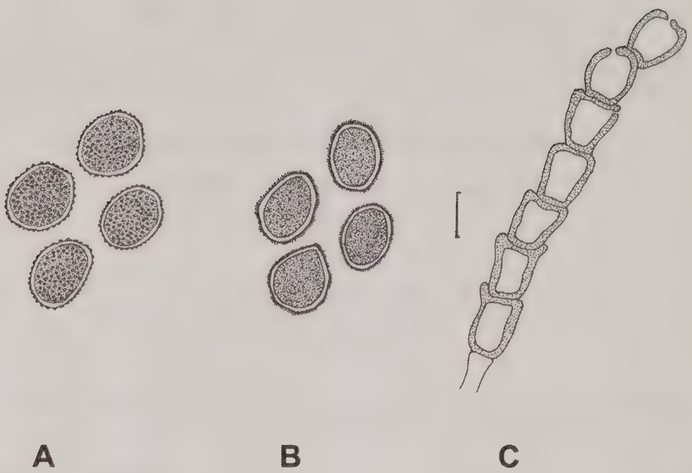

Fig. 1. *Kuehneola uredinis*: ***A.*** – aeciospores; ***B.*** – urediniospores; ***C.*** – teliospores. Scale bar =15 µm

Specimens examined: Turkey, Rize Prov., Ikizdere, near Tron, on *Rubus caesius* L., 40°42’35” N, 40°36’10” E, 830 m a.s.l., 27-VII-1998, E. Hüseyin, F. Selçuk (EH 1174, FS 0120); Rize Prov., Hemşin, Gidilmişdere, on *Rubus canescens* DC., 41°3’52” N, 40°45’36” E, 1110 m a.s.l., 4-VIII-1999, E. Hüseyin, F.Selçuk (EH 1175, FS 0375); Balıkesir Prov., Ivrindi, Karasu, on *Rubus canescens*, 39°30’58” N, 27° 22’48” E, 31-V-2000, E.Hüseyin (EH 1176).

Herbarium specimens are deposited in the Herbarium of the Gazi University Kırşehir Arts and Sciences Faculty, Kırşehir, Turkey.

Kuehneola uredinis is known on *Rubus caucasicus* Focke, *R. ibericus* Juz., *R. sanguineus* Friv., *R. caesius, R. glandulosus* Bell., *R. hirtus* Waldst. & Kit., *R. fruticosus* L. and other species of *Rubus* from Europe, Asia, North America, South Africa and New Zealand (Wilson & Henderson 1966; Kuprevich & Ulijanizshev 1975; Ellis & Ellis 1987; Denchev 1995).

Before our investigations 290 species from 13 genera of rust fungi were reported from Turkey (Tamer & al. 1998; Kırbag, Civelek & Hüseyinov 2001; Hüseyin & Kırbag 2003). There are no records of the genus *Kuehneola* Magnus in these publications. This is the first report of genus *Kuehneola* and *K. uredinis* from Turkey. This fungus was registered on *Rubus canescens* and *R. caesius*.

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Fungi of 'alpine islands' of *Dryas octopetala* in the Carpathians

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Abstract–39 ascomycete fungi and some anamorphs are reported from the Western and Eastern Carpathians, among them *'Lachnum crystallophorum', Leptosphaeria holmiorum, Odontotrema alpinum* and *Urceolella dryadicola*. Analysis of *Dryas*-specific fungi of the Carpathians, Alps, Scandinavia and the Urals shows some similarities between these areas. This indicates that the Carpathian population of *Dryas octopetala* has been influenced by migrational waves of *Dryas,* as much from the west (the Alps), as from the east (the Urals and Scandinavia). The most similar populations were found in the Malá Fatra Mts., Chočské vrchy Mts., Západné (Zachodnie) Tatry Mts., Vysoké Tatry Mts. and Bielanske Tatry Mts. The most distinct and isolated areas is the western part of the Tatry Mts., named the Zachodnie Tatry Mts., which have a greater number of exclusive species and a single endemite, *Melanomma margaretae*. The dispersion of fungi in smaller 'islands' is mostly accidental, resulting from the decline of the host population and the extinction of fungi that follows it.

Key words–arcto-alpine fungi, distribution, mycogeography

Introduction

Dryas octopetala was first reported by Wahlenberg (1814) from the Chočské vrchy Mts. in the Slovakian Carpathians. Later it was reported from the Zachodnie Tatry Mts. (Herbich 1831; Fritze & Ilse 1870; Kotula 1889-1890, Berdau 1890, Sagorski & Schneider 1891), Malá Fatra Mts. (Brancsik 1862; Holuby 1888), Belianske Tatry Mts. (e.g., Krajina 1925; Domin 1925, 1926), Nízke Tatry Mts. (e.g., Trapl 1930; Sillinger 1933) and Svidovets Mts. (e.g., Domin 1929; Klášterský 1930); see also Zahradníková, (1992). More recently Milkina (1995) found a new locality of *D. octopetala* in the Eastern Carpathians (Chornohora Mts.). The biggest plant populations inhabit the Západné (Zachodnie) and Belianske Tatry Mts. Smaller populations where noted in the Malá Fatra Mts., Chočské vrchy Mts., Nízke Tatry Mts. (Krakova hoľa Mt.), Svidovets Mts. and Rarâu Mts. Very small relict populations have survived on a single rock wall in the 'Biała Woda' Nature Reserve in the Pieniny Mts. (Kornaś 1958). Other very small populations were noted in the Súlovské vrchy Mts., Bába Mt. in the Nízke Tatry Mts. and the slope of Pop Ivan Mt. and Berbenieskul Mt., both in the Chornohora Mts. The species was widely distributed in the lowlands of Central Europe during the glacial period, as indicated by fossil records of *Dryas octopetala* from Europe reported by Tralau (1961). At present the host plant inhabits only 'island' areas in the mountains.

Fungi – 23 taxa of fungi have been found on *Dryas octopetala* occurring in the Carpathians so far (Velenovský 1934; Sandu-Ville 1967; Sałata *et al.* 1984; Bontea 1985; Eliade 1990; Chlebicki 1995, 2002; Lizoň & Bacigálová 1998; Lizoň & Jančovičová 2000). Of them, *Patinella dryadea* Vel. in fact is a lichenized fungus (Chlebicki 1995; Lizoň & Jančovičová 2000). Moreover, *Rosellinia riminicola* Rehm and *Septoria semilunaris* Johans. seem to be doubtful taxa. Altogether 96 taxa (excluding endophytes) have been noted on the plant. Well known, detailed investigations of the dryadicolous fungi in some populations of *Dryas octopetala* were conducted in Europe (L. Holm 1979; K. Holm & L. Holm 1985, 1993; Graf 1986; Nograsek 1990; Nograsek & Matzer 1991; L. Holm & K. Holm 1993; Chlebicki 1995, 2002). In addition, 63 species of endophytes were noted on plants found in the Alps and the Arctic (Fisher *et al.* 1995; Robinson *et al.* 1998). More investigations were conducted in Arctic Canada (Barr 1959), Greenland (Chlebicki & Knudsen 2001; Chlebicki & Raitviir 2003), the Far East (Vassiljeva 1979, 1987, 1998) and Western Siberia (Chlebicki 1998, 2002)..

Material and Methods

The material gathered by the authors came from the western and eastern parts of the Carpathian Mountains: Tatry Mts., Nízke Tatry Mts., Malá Fatra Mts., Svidovets Mts., Chornohora Mts. and Rarâu Mts. In addition, the collections of *Dryas octopetala* in the Czech and Polish herbaria, such as PRC, PR and KRAM, were researched using Rostrup's method. Plants from 248 collections (70 from PRC, 82 from PR, 96 from KRAM) were screened with a Nikon SMZ 1500 dissecting microscope and examined in Zeiss and Olympus BX-51 transmitted light microscopes afterwards. Measurements of anatomical characters were taken from tissues placed in distilled water. The material is deposited in PRC, PR, PRM and KRAM. The Latin names of the orders follow Kirk *et al.* (2001). The phytogeographical division of the Carpathians follows Bertová (1984). The phytogeographical analysis was preformed using the mycogeographical method described by Chlebicki (2002). The species of the genera *Mycosphaerella*, *Eurotium*, *Septoria* and *Stagonospora*, as well as plurivorous species, were excluded from the mycogeographical analysis.

Results

Acanthostigma longisporum (Remler) Réblová & M.E. Barr, Sydowia 52: 264, 2000. *Pleosporales*

This rare species was earlier reported from the Alps and Scandinavia (Nograsek 1990). It was also found in the Western Carpathians on the Polish side of the Zachodnie Tatry Mts. (Chlebicki 1995, 2002).

Cainiella johansonii (Rehm) E. Müll., Sydowia 10: 121, 1957. *Xylariales*

SPECIMENS EXAMINED – Western Carpathians – Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., Plačlivý Roháč [Plačlivé] Mt., ca 1900 m elev., on dead petioles, July 1928, coll.: *J. Dostál,* PRC; Liptovské hole Mts., on slope of Jakubina Mt. in Račková dolina (valley), ca 2050 m elev., on stipules, 24 July 1931, coll.: *J. Dostál,* PRC; (POLAND) – Zachodnie Tatry Mts., Ciemniak Mt., Stoły Rocks, on vein of lower side of leaf, 26 July 2002, coll.: *A. Chlebicki,* KRAM; Nízke Tatry Mts. (SLOVAKIA) – Krakova hoľa Mt., 48° 59’ 07” N, 19° 37’ 59” E, 1730-1750 m elev., on lower side of leaves, 23 September 2003, coll.: *A. Chlebicki & M. Suková,* KRAM, PRM 901048.

Comments – It has not been reported from the Carpathians so far, but it is not a rare species, noted on leaves of *D. octopetala, D. integrifolia* and *D. drummondii* (L. Holm 1979; Barr 1959; Spooner 1981; Nograsek 1990; Fisher *et al.* 1995; Chlebicki 1995, 1998, 2002; Vassiljeva 1998; Chlebicki & Raitviir 2003).

Crocicreas dryadis (Nannf. ex L. Holm) S. E. Carp. var. ***dryadis*** Brittonia 32: 270, 1980. *Helotiales*

SPECIMENS EXAMINED – (all collections on lower side of leaves of *Dryas octopetala*) **Western Carpathians –** Fatra (SLOVAKIA) – Malá Fatra Mts., Kriváň Mt., near hostel, 1 August 1919, coll.: *K. Domin,* PRC; Malá Fatra Mts., Kriváň Mt., 15 July 1920, coll.: *J. Klika,* PRC; Malá Fatra Mts., Veľký Rozsutec Mt., ca 1600 m elev., 28 June 1925, coll.: *F. Maloch,* PRC; Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13’ N, 19° 06’ E, 1590 m elev., 6 October 2001, coll.: *A. Chlebicki,* KRAM; Chočské vrchy Mts., Veľký Choč Mt., 28 July 1919, coll.: *K. Domin,* PRC; Chočské vrchy Mts., Veľký Choč Mt., ‘*Dryadetum*’ 1550 elev., 10 July 1928, coll.: *P. Sillinger,* PRC; Chočské vrchy Mts., Veľký Choč Mt., 18 June 1937, s. coll. nom., PRC; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., ‘Biela skala above Zuberec, ca 1750 m elev.’ [ridge between Radové skaly rocky peak (1557 m elev.) and Sivý vrch Mt. (1805 m elev.) on current maps], 15 August 1928, coll.: *J. Dostál,* PRC; Liptovské hole Mts., Bobrovec Mt., 1664 m elev., 12 August 1928, coll.: *J. Dostál,* PRC; Liptovské hole Mts., Plačlivý Roháč [Plačlivé] Mt., 5 August 1928, coll.: *J. Dostál,* PRC; Liptovské hole Mts., Plačlivý Roháč [Plačlivé] Mt., 1800-1900 m elev., 5 August 1928, coll.: *J. Dostál,* PRC; Zachodnie Tatry Mts. (POLAND) – Ciemniak Mt., Stoły Rocks, 26 July 2002, coll.: *A. Chlebicki,* KRAM; Vysoké Tatry Mts. (SLOVAKIA) – Podtisovky, SSW of Tisovka Mt. in Bielovodská dolina (valley), 18 July 1925, coll.: *I. Klášterský,* PRM 901046; Zámky Mt., 9 July 1925, coll.: *V. Krajina,* PRC; Belianske Tatry Mts. (SLOVAKIA) – Muráň Mt., 1800 m elev., 14 August 1925, coll.: *K. Domin,* PRC; Faixová ridge [ridge with a number of rocky peaks going in ESE direction from Skalné Vráta Mt. to the beginning of Dlhá stěna (rocky wall)], 1550 m elev., 21 July 1928, coll.: *V. Krajina,* PRC; N slope of Muráň Mt., 14 August 1925, coll.: *V. Krajina,* PRC; Belianske Tatry Mts., locality not given, July 1933, coll.: *K. Domin, Kettnerová, V. Krajina,* PRC; Nízke Tatry Mts.

(SLOVAKIA) – Bába Hill E of village of Lučivná, 4 September 1920, coll.: *K. Domin,* PRC; **Eastern Carpathians** – Svidovets Mts. (UKRAINE), Bliznitsa Mt., July 1918, coll.: *A. Margittai,* PRC.

Comments – Chlebicki (1995, 2002) reported 13 localities of the fungus from the Wysokie and Zachodnie Tatry Mts., as well as from Bliznitsa Mt. (Svidovets Mts.) and Berbenieskul Mt. (Chornohora Mts.), both in the Eastern Carpathians. It can be considered as a common species in the Carpathians, earlier noted in Sweden (L. Holm 1979), Iceland (K. Holm & L. Holm 1984), Austria (Nograsek & Matzer 1991), Bosnia, Herzegovina, Croatia, Finland, Poland, Russia and Slovakia (Chlebicki 1995, 2002).

Crocicreas dryadis (Nannf. ex L. Holm) S. E. Carp. var. ***uniseptata*** Nograsek & Matzer, Nova Hedwigia 53: 451, 1991. *Helotiales*

Apothecia darker than in the type variety, ascospores two-celled 8.8-10.4 x 2.1-2.4 μm.

SPECIMENS EXAMINED – **Western Carpathians** – Fatra (SLOVAKIA) – Malá Fatra Mts., Kriváň Mt., on lower side of dead leaves, 2 August 1919, coll.: *K. Domin,* PRC; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., 'Dolina Rozpadlica' (valley) – at present probably Rozpadlý grúň valley SE of saddle between Krzesanica Mt. and Małołączniak Mt., see KOTULA, (1889-1890), 1500 m elev., on lower side of dead leaves, 22 August 1930, coll.: *J. Dostál,* PRC.

Comments – The species was reported from the Alps and Scandinavia (Nograsek & Matzer 1991; Chlebicki 1995), Scotland (Spooner 1981), Iceland (K. Holm & L. Holm 1984) and Novaya Zemlya (Chlebicki 2002).

Crocicreas variabile Nograsek & Matzer, Nova Hedwigia 53: 453, 1991. *Helotiales*

Apothecia cup-shaped, pale olivaceous, ascospores hyaline, four-celled (14)15.5-18.5 x 2-3 μm.

SPECIMENS EXAMINED – (all collections on lower side of leaves of *Dryas octopetala*) **Western Carpathians** – Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., on slope of Jakubina Mt. in Račková dolina (valley), ca 2050 m elev., 24 July 1931, coll.: *J. Dostál,* PRC; (POLAND) – Zachodnie Tatry Mts., Mt. Ciemniak, (Stoły Rocks), 10 September 1995, *coll. A. Chlebicki,* KRAM F; Vysoké Tatry Mts. (SLOVAKIA) – 'Bolond-Gero' (?), ca 1800 m elev., July 1926, coll.: *A. Margittai,* PRC; Wysokie Tatry Mts. (POLAND) – Szpiglasowa Pass, 12 September 1995, *coll. A. Chlebicki,* KRAM F; Belianske Tatry Mts. (SLOVAKIA) – 'Distr. Kežmarok, Kopa' (Belianska Kopa) Mt., see KRAJINA, (1925), 19 June 1924, coll.: *V. Krajina,* PRC.

Comments – An arcto-alpine species, earlier reported from the Alps, Sweden (Nograsek & Matzer 1991), Tatry Mts., Urals and Greenland (Chlebicki 2002).

Didymosphaeria massarioides Sacc. & Brunaud, Michelia 2: 392, 1881. *Pleosporales*

It is a cosmopolitan species, noted on various plants, among them *Dryas octopetala* (Nograsek & Matzer 1991; Atproot 1995). Chlebicki (2002) noted it on *Dryas* wood in the Pieniny Mts. in the western Carpathians.

Discosia strobilina Lib. Pl. Crypt. Ard. exs. 346, 1837. Anamorphic fungus

A species with a wide distribution, noted on various host plants (Subramanian & Chandra-Reddy 1974). More recently Chlebicki (1995) reported two finds from the Zachodnie Tatry Mts. in the Western Carpathians.

Eurotium herbariorum Link : Fr., Systema Mycologicum 3: 332, 1832. *Eurotiales*

Ascomata globose, circular, yellow, ascospores circular, 7.5-9 μm diam. in face view, 4.3-5.8 μm wide in lateral view, with two minutely roughened ridges.

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Kriváň Mt., on both sides of leaves and petioles of *Dryas octopetala*, July 1924, coll.: *S. Trapl*, PRC.

Comments – It is widespread species. Its minute, yellow ascocarps are reported on many products such as cheeses, meats and fruits (Pitt & Hocking 1997). It was sometimes noted on herbarium plants (Dennis 1968). Earlier it was reported from leaves of *D. octopetala* collected in the Zachodnie Tatry Mts. (Chlebicki 2002).

Gnomonia dryadis Auersw., Mycol. Europ. 5/6: 26, 1869. *Diaporthales*

Ascospores hyaline, (13)14.5-17.5(21.5) x 4-7 μm, with cone-shaped (2.5-6.5 μm long) to filiform (8-14.5 μm long) appendages.

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Suchý Mt., on twig, 3 June 1926, coll.: *J. Klika*, PRC; Malá Fatra Mts., Veľký Rozsutec Mt., on twig, July 1900, coll.: *C. Brancsik*, PRC; Malá Fatra Mts., Veľký Rozsutec Mt., ca 1600 m elev., on twigs, 28 June 1925, coll.: *F. Maloch*, PRC; Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., on dead twigs, 6 October 2001, coll.: *A. Chlebicki*, KRAM; Chočské vrchy Mts., Veľký Choč Mt., 29 May 1926, coll.: *J. Klika*, PRC; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., on slope of Jakubina Mt. in Račková dolina (valley), ca 2050 m elev., on petiole, 24 July 1931, coll.: *J. Dostál*, PRC; Vysoké Tatry Mts. (SLOVAKIA) – Zámky Mt., on petiole and stipules, 9 July 1925, coll.: *V. Krajina*, PRC; Nízke Tatry Mts. (SLOVAKIA) – Krakova hoľa Mt., 48° 59' 07" N, 19° 37' 59" E, 1730-1750 m elev., on twig, 23 September 2003, coll.: *M. Suková & A. Chlebicki*, PRM 901049; **Eastern Carpathians** – Rarău Mts. (ROMANIA) – Pietrele Doamnei rocks, at 1653 m elev., 4 October 2002, coll.: *A. Chlebicki*, KRAM.

Comments – The appendage seems to be rolled and this is the reason for its cone shape. Appendages of ascospores became filiform and long when immersed in water. The presence of appendages in the Carpathian specimens indicates its Scandinavian origin. The specimens from the Alps are devoid of such appendages (Nograsek 1990). The specimens from the Carpathians possess mostly 8-sporous asci. The 16-sporous asci were present in the single collection from the Nízke Tatry Mts. The species was earlier noted in the Alps, Scandinavia (L. Holm 1979; K. Holm & L. Holm 1985; Nograsek 1990), Canadian Arctic (Barr 1959, 1978), Spitsbergen (K. Holm & L. Holm 1993), Tatry Mts., Pyrenees, Yugoslavia (Chlebicki 1995), Sayan Mts. and Greenland (Chlebicki & Knudsen 2001).

Isothea rhytismoides (Bab. ex Berk.) Fr., Summa Veg. Scand.: 421, 1849. *Phyllachorales*

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Kriváň Mt., near hostel, 1 August 1919, coll.: *K. Domin,* PRC; Malá Fatra Mts., Kriváň Mt., on upper side of leaves, 15 July 1920, coll.: *J. Klika,* PRC; Veľký Kriváň Mt., 1400-1600 m elev., 7 August 1967, coll.: *J. Soják,* PR; Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., on living leaves, 6 October 2001, coll.: *A. Chlebicki,* KRAM; Chočské vrchy Mts., Veľký Choč Mt., 1617 m elev., on upper side of leaves, 10 September 1922, coll.: *F. Maloch,* PRC; Chočské vrchy Mts., Choč (Veľký Choč) Mt., 18 June 1937, s. nom. coll., PRC; Veľký Choč, ca 1600 m elev., 22 August 1941, coll.: *I. Klášterský,* PR; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., Bobrovec Mt., 1664 m elev., 12 August 1928, coll.: *J. Dostál,* PRC; Liptovské hole Mts., foot of Plačlivý Roháč [Plačlivé] Mt. in Smutná dolina (valley), ca 1650-1700 m elev., on upper side of leaves, August 1926, coll.: *J. Dostál,* PRC; Vysoké Tatry Mts. (SLOVAKIA) – Zámky Mt., on upper side of leaves, 9 July 1925, coll.: *V. Krajina,* PRC; Belianske Tatry Mts. (SLOVAKIA) – on leaves, 29 August 1919, coll.: *K. Domin,* PRC; Muráň Mt., 1800 m elev., 14 August 1925, coll.: *K. Domin,* PRC; Hlúpy vrch, ca 1900 m elev., July 1938, coll.: *M. Deyl,* PR; **Eastern Carpathians** – Svidovets Mts. (UKRAINE) – Bliznitsa Mt., ca 1875 m elev., 13 July 1932, coll.: *D. Žofák,* PRC; Chornohora Mts. (UKRAINE) – Černá hora, locality not given, August 1938, coll.: *E. Hadač,* PR; Rarâu Mts. (ROMANIA) – Pietrele Doamnei Rocks, at 1653 m elev., on upper side of leaves, 4 October 2002, coll.: *A. Chlebicki,* KRAM.

Comments – *I. rhytismoides* occurs in the whole range of *Dryas* species (Chlebicki 2002). It was noted in the Tatra Mts., Chornohora Mts. and Svidovets Mts. (Chlebicki 2002). We observed leaves grazed by insects in places covered by fungus ascomata.

'Lachnum crystallophorum' Nograsek & Matzer, Nowa Hedwigia 53: 455, 1991. *Helotiales*

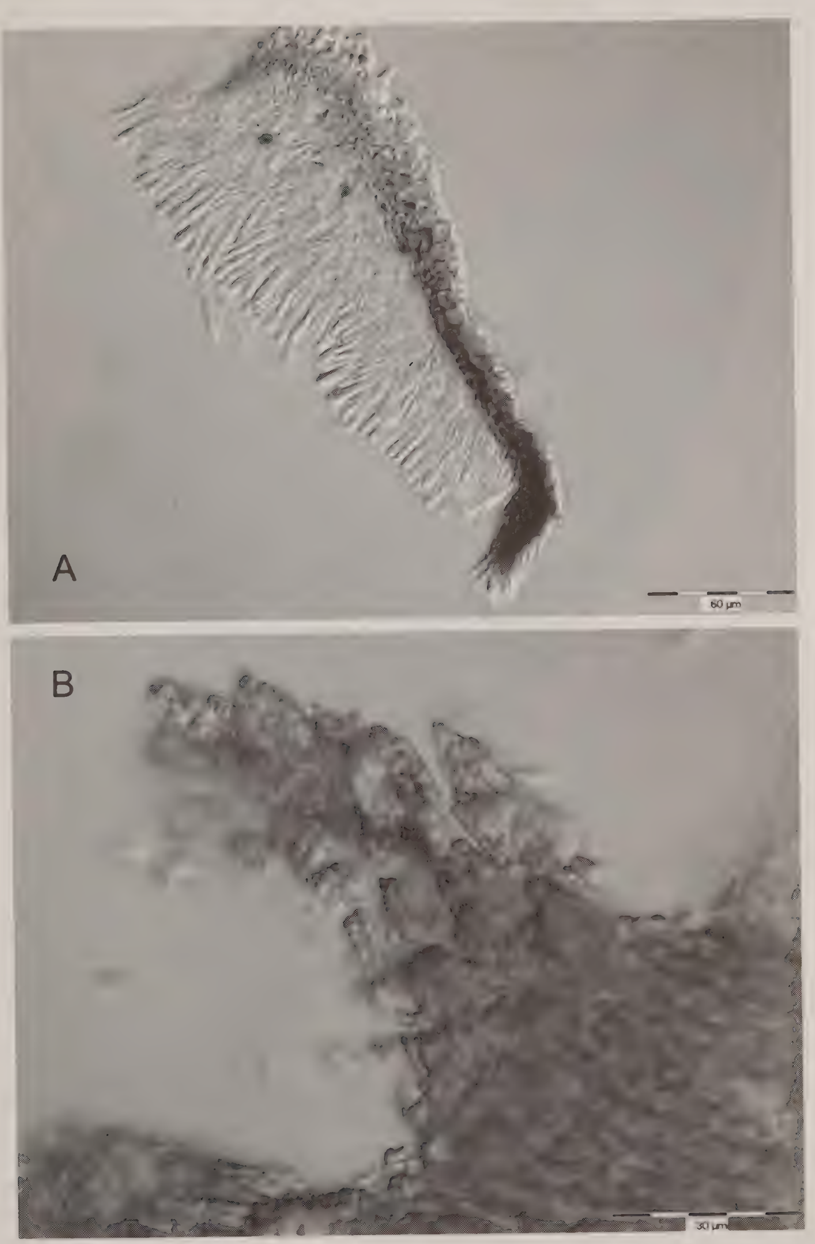
Apothecia minute, short-stalked, covered by scabrous hairs bearing white crystals, hairs in small clusters forming teeth at margin of apothecium, outer excipulum brown, composed of isodiametric (surface layers) to elongated (inner layers) cells, asci 25.5-33 x 4.5-5.5 μm, the asco-apical apparatus IKI red and KOH/IKI blue, ascospores hyaline, one-celled, 6.5-8.5 x 1-1.5 μm, paraphyses filiform, 1-1.2 μm wide (Fig. 1, 2).

SPECIMENS EXAMINED – Eastern Carpathians – Rarâu Mts. (ROMANIA) – Pietrele Doamnei Rocks, at 1653 m elev., on lower side of leaves of *Dryas octopetala,* 4 October 2002, coll.: *A. Chlebicki,* KRAM.

Comments – It is a very characteristic species, with white crystals covering almost all the surface of the hair. Its belonging to the genus *Lachnum* is provisional because of the presence of rounded tips of paraphyses. Previously, it was known only from the Alps (Nograsek & Matzer 1991). Possibly it is a member of the genus *Incrupila* (H.O. Baral, in letter).

Leptosphaeria dryadophila Huhndorf, Illinois Nat. Hist. Surv. Bull. 34: 484, 1992. *Pleosporales*

Fig. 1. '*Lachnum crystallophorum*': A – excipulum in longitudinal section (in lactophenol), scale bar = 40 μm; B – hairs (in water using Nomarski contrast), scale bar = 4 μm; C – margin of apothecium with teeth (in water), scale bar = 30 μm.


A
60 µm
B
30 µm

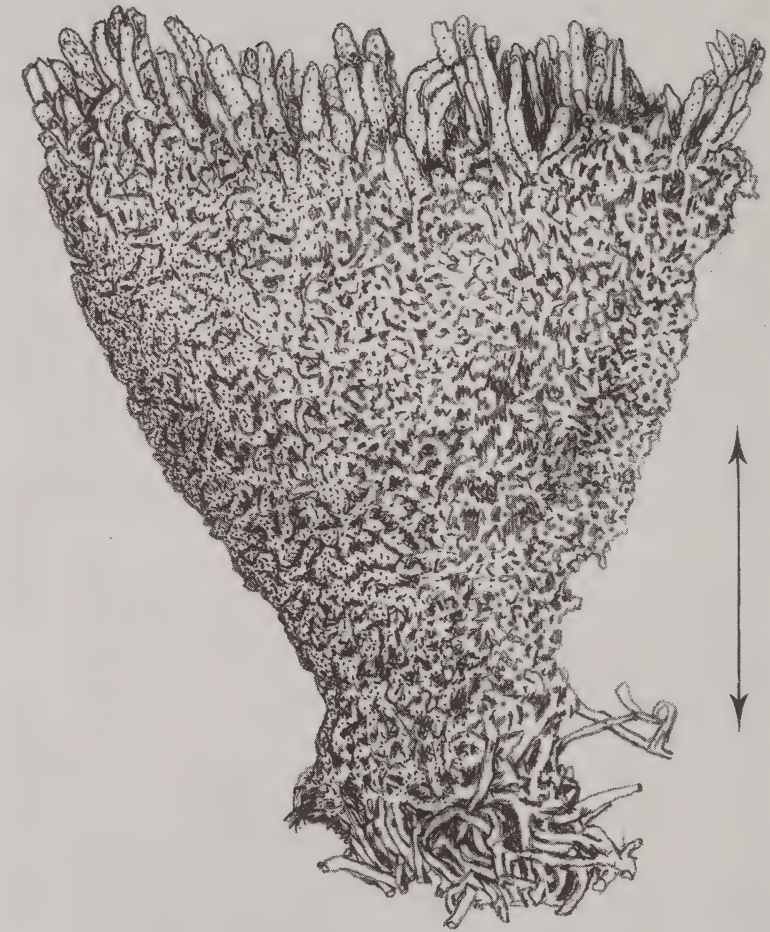


Fig. 2. Apothecium of '*Lachnum crystallophorum*', scale bar = 50 μm

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., on dead hypanthium, 6 October 2001, coll.: *A. Chlebicki,* KRAM; Nízke Tatry Mts. (SLOVAKIA) – Krakova hoľa Mt., 48° 59' 07" N, 19° 37' 59" E, 1730-1750 m elev., on previous year's hypanthia, 23 September 2003, coll.: *M. Suková & A. Chlebicki,* KRAM, PRM 901050; **Eastern Carpathians** – Rarâu Mts. (ROMANIA) – Pietrele Doamnei Rocks, at 1653 m elev., on dead hypanthium, 4 October 2002, coll.: *A. Chlebicki,* KRAM.

Comments – Its occurrence is restricted to the host inflorescences (Fig. 3A). The adult ascomata occur on dead sepals of the previous year's hypanthia and fruits. The fungus was noted in Alaska (Sprague 1955), the Alps (Müller 1950), Greenland, Iceland, Novaya Zemlya, Scandinavia, Spitsbergen (Lind 1910; L. Holm 1957, 1979; Nograsek 1990; K. Holm & L. Holm 1993), Rarâu Mts. in the Eastern Carpathians (Chlebicki 1995), Kamchatka (Vassiljeva 1987) and Greenland (Chlebicki & Knudsen 2001). It is more common in the sub-Arctic and the Arctic than in alpine regions.

Leptosphaeria holmiorum Chleb., Mycotaxon 86: 218, 2003. *Pleosporales*

Ascocarps superficial, ostiole ca 40 μm diam, asci tetrasporous, 103-126 x 23-27 μm, ascospores mostly four-celled, olivaceous to light brown, upper median cell darker, distal cells paler, 31.5-42 x 12-12.5 μm (Fig. 3B, 4A).

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Veľký Rozsutec Mt., on dead petiole of *Dryas octopetala,* July 1900, coll.: *C. Brancsik,* PRC.

Comments – It is a rare species, known from the Polar Urals, Chukotka Peninsula and the Caucasus (Chlebicki & Raitviir 2003). The Carpathian specimens differ from the type only by the presence of constantly four-celled ascospores. It seems to have been coexisting with *Dryas* for a long time.

Leptosphaerulina dryadis (Starbäck) L. Holm, Bot. Notiser 132: 86, 1979. *Pleosporales*

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Veľký Rozsutec Mt., July 1900, coll.: *C. Brancsik,* PRC; Chočské vrchy Mts., Veľký Choč Mt., on upper side of leaves, 28 July 1919, coll. *K. Domin,* PRC; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., 'Biela skala' above Zuberec, ca 1750 m elev. [ridge between Radové skaly rocky peak (1557 m elev.) and Sivý vrch Mt. (1805 m elev.) in current maps], on upper side of leaves, 15 August 1928, coll.: *J. Dostál,* PRC; Liptovské hole Mts., Plačlivý Roháč (Plačlivé) Mt., ca 1900 m elev., on petiole, July 1928, coll.: *J. Dostál,* PRC; Liptovské hole Mts., on slope of Jakubina Mt. in Račková dolina (valley), ca 2050 m elev., on petioles and peduncle, July 1931, coll.: *J. Dostál,* PRC; Liptovské hole Mts., 'Dolina Rozpadlica' (valley) – at present probably Rozpadlý grúň valley SE of saddle between Krzesanica Mt. and Małołączniak Mt., see Kotula, (1889-1890), 1500 m elev., on lower side of dead leaves, 22 August 1930, coll.: *J. Dostál,* PRC; Vysoké Tatry Mts. (SLOVAKIA) – Zámky Mt., on peduncle and upper side of leaves, 9 July 1925, coll.: *V. Krajina,* PRC; Belianske Tatry Mts. (SLOVAKIA) – Hlúpy vrch Mt., 1920 m elev., on upper side of leaves, 11 July 1991, coll.: *D. Jalovičiarová,* PRC; **Eastern Carpathians –** Maramureş mountain range (ROMANIA) – NNE of village of Repedea, Mihailecul Mt., 1910-1920 m elev., on lower side of leaves, 30 June 2003, coll.: *M. Suková,* PRM 901043.

Comments – It is a widely distributed species, known from Europe (L. Holm 1979; Nograsek 1990; Chlebicki 1995, 2002), Siberia, Korea (Chlebicki 2002), the Far East in Asia (Vassiljeva 1987), and North America (Barr, in letter). It was also noted in the Zachodnie Tatry Mts. (Western Carpathians), Chornohora Mts. and Rarâu Mts. in the Eastern Carpathians (Chlebicki 1995).

Leptosphaerulina pulchra (G. Winter) M.E. Barr, Contr. Inst. Bot. Univ. Montréal 73: 7, 1959. *Pleosporales*

Ascocarps minute, conical, ascospores yellow brown, clavate (Fig. 4B) 19-25 x 8-9 μm.

SPECIMENS EXAMINED – Western Carpathians – Nízke Tatry Mts. (SLOVAKIA) – Bába Hill E of village of Lučivná, on dead peduncle of *Dryas octopetala,* 4 September 1920, coll.: *K. Domin,* PRC.

Comments – This arcto-alpine species was reported on various host plants from the genera *Potentilla, Dryas, Erigeron, Helianthemum, Senecio* and *Sieversia* (Barr 1959; Crivelli 1983; Vassiljeva 1998).

Lophiostoma macrostomum (Tode : Fr.) Ces. & De Not., Comm. Soc. Critt. Ital. 1: 219, 1863. *Pleosporales*

SPECIMENS EXAMINED – (on *Dryas octopetala*) **Western Carpathians** – Fatra (SLOVAKIA) – Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., on dead twigs, 6 October 2001, coll.: *A. Chlebicki,* KRAM; Zachodnie Tatry Mts. (POLAND) – Ciemniak Mt., Stoły Rocks, on dead twigs, 26 July 2002, coll.: *A. Chlebicki,* KRAM.

Comments – It is a plurivorous species noted on ligneous and herbaceous substrata, reported earlier in the Zachodnie Tatry Mts. (Chlebicki 2002).

Lophiostoma winteri (Sacc.) G. Winter in Rabenh., Krypt.-Fl., 2. Aufl., 1, 2: 297, 1885. *Pleosporales*

SPECIMENS EXAMINED – (on *Dryas octopetala*) **Western Carpathians** – Nízke Tatry Mts. (SLOVAKIA) – Krakova hoľa Mt., 48° 59' 07" N, 19° 37' 59" E, 1730-1750 m elev., 23 September 2003, coll.: *A. Chlebicki & M. Suková,* KRAM; **Eastern Carpathians** – Rarâu Mts. (ROMANIA) – Pietrele Doamnei rocks, at 1653 m elev., on dead twigs of *Dryas octopetala,* 4 October 2002, coll.: *A. Chlebicki,* KRAM.

Comments – It is a plurivorous species, reported from Sweden, Spitsbergen, the Alps, Carpathians (Zachodnie Tatry Mts., Rarâu Mts.), Polar Urals and Caucasus (L. Holm & K. Holm 1988; Chlebicki 1995, 2002).

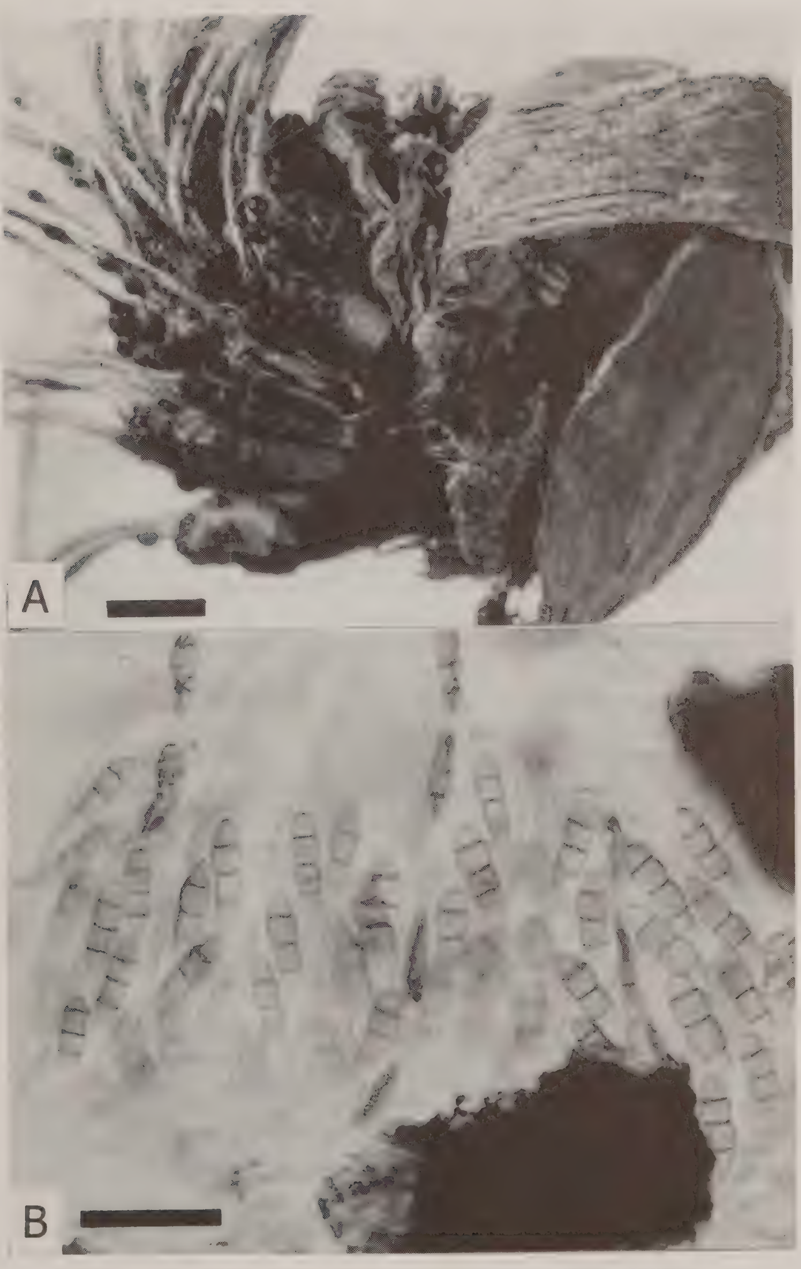
Massarina balnei-ursi (Rehm) K. Holm & L. Holm, Sydowia 38: 142, 1985. *Pleosporales*

Ascocarps black, partially embedded in decorticated wood, asci 110-150 × 10-16.5 μm, ascospores hyaline, 18-24.5 x 5-9.6 μm with gelatinous coating 2 μm thick.

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Suchý Mt., on end of broken twig, July 1891, coll.: *J. Wagner,* PRC; Zachodnie Tatry Mts. (POLAND) – Ciemniak Mt., Stoły Rocks, on dead twigs, 26 July 2002, coll.: *A. Chlebicki,* KRAM; Nízke Tatry Mts. (SLOVAKIA) – Krakova hoľa Mt., 48° 59' 07" N, 19° 37' 59" E, 1730-1750 m elev., on dead twigs, 23 September 2003, coll.: *A. Chlebicki & M. Suková,* KRAM; **Eastern Carpathians** – Rarâu Mts. (ROMANIA) – Pietrele Doamnei Rocks, at 1653 m elev., on dead twigs, 4 October 2002, coll.: *A. Chlebicki,* KRAM.

Comments – This lignicolous saprotroph was reported from the Alps (K. Holm & L. Holm 1985; Nograsek 1990), Sweden (Nograsek 1990), Polar Urals and Yakutia (Chlebicki 2002).

Fig. 3. A – ascocarps of *Leptosphaeria dryadophila* on inflorescence of *Dryas octopetala,* scale bar = 1 mm; B – asci and ascospores *of Leptosphaeria holmiorum,* scale bar = 50μm


A
B

Massarina corticola (Fuckel) L. Holm, Symb. Bot. Upsal. 14, 3: 147, 1957. *Pleosporales*

A plurivorous species, reported also on twigs of *D. octopetala* from the Pieniny Mts., the lowest locality in the Western Carpathians (Chlebicki 2002).

Melanomma margaretae Chleb., Monogr. Bot. 90: 91, 2002. *Pleosporales*

It is tentatively placed in the genus *Melanomma* because of the radiating wall structure and scleroplectenchymatic cells resembling those of *Leptosphaeria*. It was noted in the Zachodnie Tatry Mts. (Chlebicki 2002).

Mycosphaerella octopetalae (Oudem.) Lind, Rep. Sci. Res. Norw. Exp. Nov. Zemlya 19: 12, 1921. *Mycosphaerellales*

Ascocarps partially immersed, scattered, ascospores hyaline, two-celled, 21-24.5 x 8.7-10.3 μm.

SPECIMENS EXAMINED – Eastern Carpathians – Maramureş mountain range (ROMANIA) – NNE of village of Repedea, Mihailecul Mt., 1910-1920 m elev., on upper side of dead leaves of *Dryas octopetala,* 30 June 2003, coll.: *M. Suková,* PRM 901044.

Comments – It is the most common fungus on *Dryas*, see L. Holm, (1979). However, usually empty ascomata or anamorphs of the genus *Asteromella* Pass. & Thüm. were found on the leaves. Its determination was rather impossible.

Mycosphaerella ootheca (Sacc.) Magnus in Dalla Tore, Fl. Tirol 3: 381, 1913. *Mycosphaerellales*

Ascomata immersed, asci saccate, ascospores hyaline with median septa 15-17 x 4.7-5.5 μm (Fig. 4C)

SPECIMENS EXAMINED – Western Carpathians – Nízke Tatry (SLOVAKIA) – Bába Hill E of village of Lučivná, on dead peduncle of *Dryas octopetala,* 4 September 1920, coll.: *K. Domin,* PRC.

Comments – *M. ootheca* described by Saccardo (1882) differs from *M. octopetalae* (Oudem.) Lind. by its somewhat shorter ascospores, 15-16 x 6-7 μm. Tomilin (1979) synonymized *M. octopetalae* and *M. ootheca* with *M. dryadis* (Auersw.) Lindau. *Mycosphaerella ootheca* differs from *M. dryadis* by its somewhat wider ascospores. The shape of the ascospores from the Carpathians differs significantly from these of *M. octopetalae.*

Mycosphaerella punctiformis (Pers.: Fr.) Starbäck, Bihang Kongl. Svenska Vetensk-Akad. Handl. 15 afd. III. nr. 2: 9, 1889. *Mycosphaerellales*

SPECIMENS EXAMINED – (on leaves of *Dryas octopetala*) **Western Carpathians** – Fatra (SLOVAKIA) – Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., 6 October 2001, coll.: *A. Chlebicki,* KRAM; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., Plačlivý Roháč (Plačlivé) Mt., 5 August 1928, coll.: *J. Dostál,* PRC; Nízke Tatry Mts. (SLOVAKIA) – Krakova hoľa Mt., 48° 59' 07" N, 19° 37' 59" E, 1730-1750 m elev., 23 September 2003, coll.: *A. Chlebicki & M. Suková,* KRAM.

Comments – The ascomata of this species are arranged in distinct groups on the leaf surface. It is a plurivorous species (Tomilin 1979), also noted on *Dryas octopetala* in the Alps (Nograsek 1990).

Mycosphaerella cfr ***tassiana*** (De Not.) Johanson, Öfversigt af K. Vetens. Akad. Förh. 1884(9): 167, 1884. var. ***tassiana*** M.E. Barr, Northern Pyrenom. 1: 23. 1957. *Mycosphaerellales*

Ascomata immersed, ascospores hyaline with submedian septa, 11-12(14) x 3-4 μm (Fig. 4D).

SPECIMENS EXAMINED – (on *Dryas octopetala*) **Western Carpathians** – Fatra (SLOVAKIA) – Chočské vrchy Mts., Choč (Veľký Choč) Mt., on leaves of *Dryas octopetala,* 29 May 1926, coll.: *J. Klika,* PRC.

Comments – It is a very common and plurivorous species, noted also on *Dryas integrifolia* Vahl. (Barr 1959; Kobayashi *et al.* 1969).

Odontotrema alpinum (Sacc.) L. Holm, Bot. Notiser 132: 80, 1979. *Ostropales*

Apothecia globose, slightly flattened, with strongly concave hymenium, ascospores hyaline, four-celled, 15-20 x 1.7-2.8 μm (Fig. 4E).

SPECIMENS EXAMINED – **Western Carpathians** – Belianske Tatry Mts. (SLOVAKIA) – on rocks between Bujačí Mt. and Jatka (Jatky) Mt., 1800-2000 m. elev., on leaves of *Dryas octopetala* among tomentum, 18 August 1967, coll.: *V. Vašak,* PRM 901047 (extracted from PR).

Comments – The species was reported from the Alps (Müller & Arx 1955; L. Holm 1979; Sherwood-Pike 1987) and Kola Peninsula (Chlebicki 2002). Chlebicki & Raitviir (2003) described *Odontotrema alpinum* var. *octopartitum* Raitv. & Chleb., a new variety of the species from Greenland. This last taxon seems to be restricted to *Dryas integrifolia* only. The type variety was also noted on *Geum* in the Alps (Sherwood-Pike 1987). The presence of *O. alpinum* in the Carpathians is noteworthy. It can be considered an old taxon.

Otthia dryadis K. Holm, L. Holm & Nograsek in Nograsek, Bibl. Mycol. 133: 172, 1990. *Dothideales*

Comments – This lignicolous species was reported from the Alps, Scandinavia (Nograsek 1990), Spitsbergen (K. Holm & L. Holm 1993), Zachodnie Tatry Mts. in the Western Carpathians (Chlebicki 1995), the Urals and Taimyr Peninsula (Chlebicki 2002).

"***Patinella dryadea***" Velen., Monographia Discomycetum Bohemiae p. 75, 1934.

Comments – Velenovský (1934) described this taxon on the basis of material from the Tatry Mts. Chlebicki (1995) recognized the type specimen as belonging to the lichenized genus *Lecidella*, see also Lizoň & Bacigálová, (1998) and Lizoň & Jančovičová, (2000).

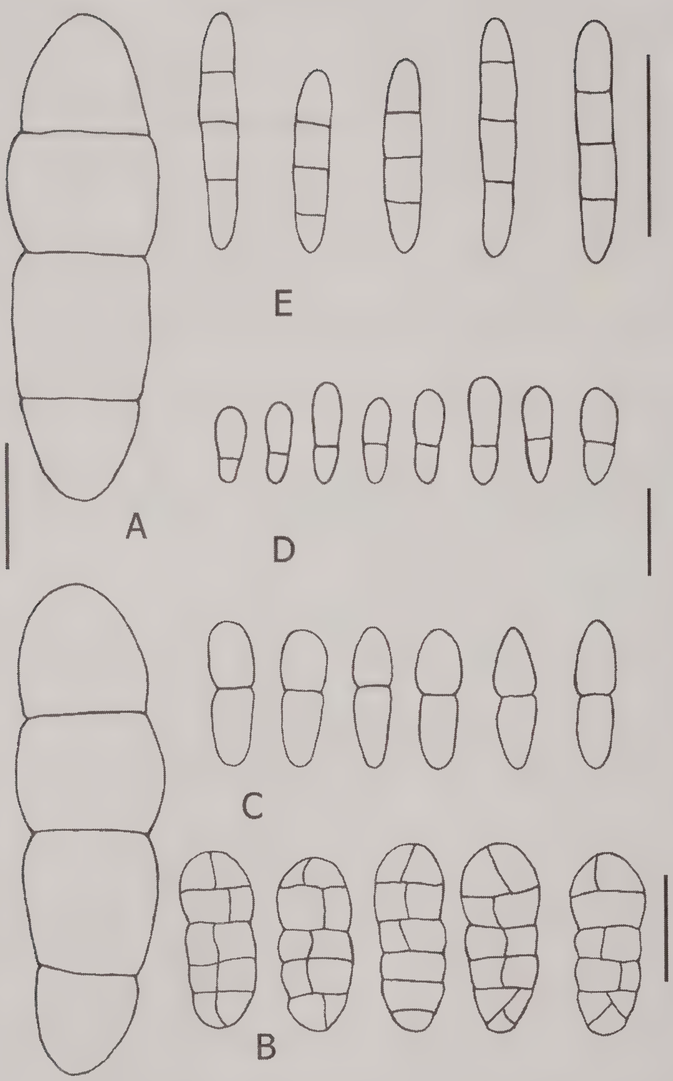


Fig. 4. A – ascospores of *Leptosphaeria holmiorum;* B – *Leptosphaerulina pulchra;* C – *Mycosphaerella ootheca;* D – *Mycosphaerella* cfr *tassiana* var. *tassiana;* E – *Odontotrema alpinum;* all scale bars = 10 μm.

Phaeosphaeria dryadea Nograsek, Bibl. Mycol. 133: 179, 1990. *Pleosporales*

Ascocarps superficial, covered by hairs, hairs brown, up to 190 x 7 μm, with one or several septa, pseudoparaphyses hyaline, septate, 0.8-2.2 μm wide, asci octosporous, cylindrical, (75)85-100 x (12.5)13.5-16.5 μm, ascospores hyaline, 4-celled, 23-27 x 5.5-8 μm.

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Suchý Mt., on upper side of leaves and adjacent part of petiole, 3 June 1926, coll.: *J. Klika,* PRC; Malá Fatra Mts., Veľký Rozsutec Mt., ca 1600 m elev., 28 June 1925, coll.: *F. Maloch,* PRC; Nízke Tatry Mts. (SLOVAKIA) – Krakova hoľa Mt., 48° 59' 07" N, 19° 37' 59" E, 1730-1750 m elev., 23 September 2003, coll.: *A. Chlebicki & M. Suková,* KRAM; **Eastern Carpathians** – Rarău Mts. (ROMANIA) – Pietrele Doamnei rocks, at 1653 m elev., on upper side of leaves and petioles, 4 October 2002, coll.: *A. Chlebicki,* KRAM.

Comments – A very characteristic species, reported from the Alps (Nograsek 1990), Carpathians (Rarău Mts.), Polar Urals, Yuzhnyj Urals, Chukotka Peninsula (Chlebicki 1995, 2002) and Greenland (Chlebicki & Raitviir 2003).

Pleospora ascodedicata K. Holm, L. Holm & Nograsek in Nograsek, Bibl. Mycol. 133: 194, 1990. *Pleosporales*

It is known from the Alps and Scandinavia (K. Holm & L. Holm 1985; Nograsek 1990), Western Carpathians (Zachodnie Tatry Mts.), Polar Urals and Yakutia (Chlebicki 1995, 2002). The species was noted in the lowest Carpathian locality of *D. octopetala* in the Pieniny Mts. (Chlebicki 2002).

Pleospora helvetica Niessl, Verhandl. Naturf. Ver. Brünn 14: 191, 1876. *Pleosporales*

Ascocarps setose or bare, ca 200 μm diam., setae 60-100 μm long, ascospores brown, 28-30 x 13-14 μm, surrounded by gelatinous coating 3 μm thick.

SPECIMENS EXAMINED – (on *Dryas octopetala*) **Western Carpathians** – Nízke Tatry (SLOVAKIA) – Bába hill E of village of Lučivná, on upper side of leaves and on petiole, 4 September 1920, coll.: *K. Domin,* PRC; **Eastern Carpathians** – Rarău Mts. (ROMANIA) – Pietrele Doamnei Rocks, at 1653 m elev., on upper side of leaves, 4 October 2002, coll.: *A. Chlebicki,* KRAM.

Comments – It is a common and plurivorous species, reported also on arcto-alpine hosts.

Pleospora penicillus (J.C. Schmidt : Fr.) Fuckel var. ***ambigua*** (Berl. & Bres.) Crivelli, Diss. ETH. 7318: 75, 1983. *Pleosporales*

SPECIMENS EXAMINED – (on *Dryas octopetala*) **Western Carpathians** – Zachodnie Tatry Mts. (POLAND) – Mt. Kominiarski Wierch, on twigs and leaves of *D. octopetala* and *Rhodiola rosea,* 7 September 1995, coll.: *A. Chlebicki,* KRAM; Mt. Ciemniak, (Stoły Rocks), on hypanthium of *D. octopetala,* 10 September 1995, coll.: *A. Chlebicki,* KRAM F.

Comments – It is a widely distributed species and noted on many host plants.

Protoventuria latispora (M.E. Barr) M.E. Barr, Can. J. Bot. 46: 851, 1968. *Pleosporales*

The fungus was noted in the Zachodnie Tatry Mts. and Pieniny Mts. in Poland, see Chlebicki, (2002). It occurs also on ericaceous hosts.

Pseudomassaria islandica (Johanson) M.E. Barr, Mycologia 56: 854, 1964. *Xylariales*

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., on dead leaves, 6 October 2001, coll.: *A. Chlebicki,* KRAM; Chočské vrchy Mts., Veľký Choč Mt., '*Dryadetum*' 1550 elev., on petiole and upper side of leaf, 10 July 1928, coll.: *P. Sillinger,* PRC; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., 'Biela skala' above Zuberec, ca 1750 m elev. [ridge between Radové skaly rocky peak (1557 m elev.) and Sivý vrch Mt. (1805 m elev.) in current maps], on stipules, petiole and upper side of leaves, 15 August 1928, coll.: *J. Dostál,* PRC; Zachodnie Tatry Mts. (POLAND) – Ciemniak Mt., Stoły Rocks, on vein of lower side of leaf, 26 July 2002, coll.: *A. Chlebicki,* KRAM; Vysoké Tatry Mts. (SLOVAKIA) – 'Bolond-Gero' (?), ca 1800 m elev., on upper side of leaf, July 1926, coll.: *A. Margittai,* PRC; Belianske Tatry Mts. (SLOVAKIA) – Faixová Ridge [ridge with a number of rocky peaks going ESE from Skalné Vráta Mt. to the beginning of Dlhá stěna (rocky wall)], 1550 m elev., on stipules and upper side of leaf, 21 July 1928, coll.: *V. Krajina,* PRC.

Comments – *Pseudomassaria islandica* is a common dryadicolous species with an amphi-atlantic distribution, noted on *Dryas octopetala, D. integrifolia* and *D. drummondii* (Chlebicki 2002).

Pseudomassaria minor (M.E. Barr) M.E. Barr, Mycologia 56: 856, 1964. *Xylariales*

Ascocarp partially immersed, 110-140 μm diam., pale internally, dark externally, apex setose, asci (8)12-16-spored, 38-53 x 11.5-18 μm, ascospores hyaline, two-celled, 9-14 x 4.2-6.5 μm.

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Veľký Rozsutec Mt., ca 1600 m elev., on dead stipules, 5 September 1967, coll.: *J. Chrtek & B. Křísa,* PRC; Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., on dead leaves, 6 October 2001, coll.: *A. Chlebicki,* KRAM; Zachodnie Tatry Mts. (POLAND) – Kalacka Turnia (crag), on dead pedicel, 3 September 1954, coll.: *J. Mądalski,* (KRAM F).

Comments – The fungus was noted on leaves of *Dryas octopetala, D. drummondii* and *D. integrifolia* (Barr 1959; Nograsek 1990; Chlebicki 1995). Chlebicki (1995) observed polysporous asci in Polish material. *P. minor* is known from Canada (Barr 1959), Austria (the Alps), Scandinavia (Nograsek 1990) and the Zachodnie Tatry Mts. (Chlebicki 1995).

Scopinella solani (Zukal) Malloch, Fungi Canadenses, no. 82, 1976. *Sordariales*

A rare fungus, noted on plant debris in Canada and Europe (Cannon & Hawksworth 1982), also on *Dryas octopetala* in the lowest locality in the Pieniny Mts. in the Western Carpathians (Chlebicki 2002).

***Septoria* sp.** Anamorphic fungus

Conidiomata black, densely distributed, cone-shaped or globose, widely opened by longitudinal slit in its upper part, conidia hyaline (3)5-8–septate, 50-90 x 1-1.5 μm.

SPECIMENS EXAMINED – Eastern Carpathians – Rarâu Mts. (ROMANIA) – Pietrele Doamnei Rocks, at 1653 m elev., on upper side of leaves, 4 October 2002, coll.: *A. Chlebicki,* KRAM.

Comments – Very similar fungi, but with shorter conidia (32-42 μm long), were noted in material from the Pyrenees, Carpathians and the Putorana Mts. in Northern Asia (Chlebicki 1995, 2002).

Sphaerotheca volkartii Blumer, Beitr. Krypt.-Fl. Schweiz 7, 1: 115, 1933. *Erysiphales*

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., on lower side of leaves of *Dryas octopetala,* 6 October 2001, coll.: *A. Chlebicki,* KRAM.; **Eastern Carpathians** – Rarâu Mts. (ROMANIA) – Pietrele Doamnei Rocks, 4 October 2002, coll.: *A. Chlebicki,* KRAM.

Comments – Earlier *Sphaerotheca volkartii* was reported from the Alps (Braun 1987, 1995), Scandinavia (L. Holm 1979), Romanian Carpathians (Sandu-Ville 1967; Eliade 1990; Chlebicki 1995), Pyrenees and Zachodnie Tatry Mts. (Sałata *et al.* 1984; Chlebicki 1995). According to Blumer (1967) it does not follow *Dryas* above 2000 m elev.

Stagonospora sp. Anamorphic fungus

Conidiomata blackish brown, opened irregularly by several valves, wall of conidioma in erumping part (valves) brown, conidia hyaline, four-celled, 19-21 x 1.7-2.0 μm.

SPECIMENS EXAMINED – Western Carpathians – Nízke Tatry Mts. (SLOVAKIA) – Bába Hill E of village of Lučivná, on upper side of leaves of *Dryas octopetala,* 4 September 1920, coll.: *K. Domin,* PRC.

Comments – Anamorphs belonging to the genus *Stagonospora* are usually connected with *Phaeosphaeria* (Leuchtmann 1984).

Stomiopeltis dryadis (Rehm) L. Holm, Bot. Notiser 132: 88, 1979. *Micropeltidaceae* (*Dothideomycetidae* inc. sed.)

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Kriváň Mt., on upper side of leaves, 2 August 1919, coll.: *K. Domin,* PRC; Chočské vrchy Mts., Veľký Choč Mt., on persisting leaf-bases and upper side of leaves, 28 July 1919, coll.: *K. Domin*, PRC; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., 'Dolina Rozpadlica' (valley) – at present probably Rozpadlý grúň valley SE of saddle between Krzesanica Mt. and Małołączniak Mt., see Kotula, (1889-1890), 1500 m elev., on lower side of dead leaves, 22 August 1930, coll.: *J. Dostál,* PRC; Vysoké Tatry Mts. (SLOVAKIA) – 'Bolond-Gero' (?), ca 1800 m elev., on upper side of leaves, July 1926, coll.: *A. Margittai,* PRC; Belianske Tatry Mts. (SLOVAKIA) – 'Distr. Kežmarok, Kopa' (Belianska Kopa) Mt., see Krajina, (1925), on stipules, 19 June 1924, coll.: *V. Krajina,* PRC; N slope of Muráň Mt., 14 August

1925, coll.: *V. Krajina,* PRC; Nízke Tatry Mts. (SLOVAKIA) – Krakova hoľa Mt., 48° 59' 07" N, 19° 37' 59" E, 1730-1750 m elev., 23 September 2003, coll.: *A. Chlebicki & M. Suková,* KRAM; Bába Hill E of village of Lučivná, on twig, 4 September 1920, coll.: *K. Domin,* PRC; **Eastern Carpathians** – Svidovets Mts. (UKRAINE) – Bliznitsa Mt., July 1918, coll.: *A. Margittai,* PRC; Maramureş mountain range (ROMANIA) – NNE of village of Repedea, Mihailecul Mt., 1910-1920 m elev., on upper side of leaves, 30 June 2003, coll.: *M. Suková,* PRM 901045.

Comments – It was earlier reported from the Alps (Rehm 1904; Nograsek 1990), Scandinavia (L. Holm 1979; Nograsek 1990), Canadian Arctic (Barr 1959, 1990), Iceland, the Faroe Islands (L. Holm 1979), Spitsbergen (K. Holm & L. Holm 1993), Pyrenees and Carpathians (Chlebicki 1995). Recently it was noted in some Carpathians ranges such as the Zachodnie Tatry Mts., Vysoké Tatry Mts., Pieniny Mts. and Svidovets Mts. (Chlebicki 2002).

Sydowiella dryadis L.N. Vassiljeva var. ***macrospora*** Nograsek in Nograsek & Matzer, Nova Hedwigia 53: 464, 1991. *Diaporthales*

SPECIMENS EXAMINED – **Eastern Carpathians** – Rarâu Mts. (ROMANIA) – Pietrele Doamnei Rocks, at 1653 m elev., on dead twigs, 4 October 2002, coll.: *A. Chlebicki,* KRAM.

Comments – *Sydowiella dryadis* var. *macrospora* was earlier noted in the Alps (Nograsek & Matzer 1991), Spitsbergen (K. Holm & L. Holm 1993), Zachodnie Tatry Mts., Svidovets Mts. (Carpathians) and the Urals (Chlebicki 2002).

Synchytrium cupulatum F. Thomas, Botan. Zbl. 29(1): 22, 1887. *Chytridiales*

This parasite occurs on living leaves, petioles, calyces and petals of *D. octopetala* and *D. integrifolia.* It is a rare fungus, so far reported from the Alps, Finland, Iceland, Spitsbergen, Chukotka Peninsula, Greenland, and Somerset Island in the Canadian Arctic (Karling 1964; Savile 1959; Chlebicki 2002; Chlebicki & Raitviir 2003). Bontea (1985) reported the species from the Romanian Carpathians.

Urceolella dryadicola Raitv., Mycotaxon 86: 222, 2003. *Helotiales*

Apothecia sessile, pale yellow, covered with white hairs, spores hyaline, fusoid to clavate-fusoid, aseptate, 7-8 x 1.3 μm, paraphyses filiform, slightly thickened at the top, not exceeding the asci.

SPECIMENS EXAMINED – **Eastern Carpathians** – Rarâu Mts. (ROMANIA) – Pietrele Doamnei Rocks, at 1653 m elev., on lower side of dead leaves, 4 October 2002, coll.: *A. Chlebicki,* KRAM.

Comments – The species has been described from Greenland (Chlebicki & Raitviir 2003). The first author found it also in material from the Canadian Arctic gathered by E. Ohenoja.

Wettsteinina dryadis (Rostr.) Petrak, Sydowia 1: 322, 1947. *Pleosporales*

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Suchý Mt., upper side of leaves, 3 June 1926, coll.: *J. Klika,* PRC; Malá Fatra Mts., Malý Kriváň Mt., 1669 m elev., 15 May 1921, coll.: *F. Maloch,* PRC; Malá Fatra Mts., Veľký Rozsutec Mt., ca 1600 m elev., on upper side of leaves, 28 June 1925, coll.: *F. Maloch,* PRC; Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., on dead leaves, 6 October 2001, coll.: *A. Chlebicki,* KRAM; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., 'Biela skala' above Zuberec, ca 1750 m elev. [probably ridge between 'Biela skala' Mt. (1316 m elev.) and Sivý vrch Mt. (1805 m elev.)], on upper side of leaves, 15 August 1928, coll.: *J. Dostál,* PRC; Liptovské hole Mts., Plačlivý Roháč (Plačlivé) Mt., ca 1900 m elev., on upper side of leaves, July 1928, coll.: *J. Dostál,* PRC; Liptovské hole Mts., foot of Plačlivý Roháč (Plačlivé) Mt. in Smutná dolina (valley), ca 1650-1700 m elev., on petioles, August 1926, coll.: *J. Dostál,* PRC; Vysoké Tatry Mts. (SLOVAKIA) – Zámky Mt., on lower side of leaves (at median furrow and main veins) and on stipules, 9 July 1925, coll.: *V. Krajina,* PRC; Belianske Tatry Mts. (SLOVAKIA) – 'Distr. Kežmarok, Kopa' (Belianska Kopa Mt.), see Krajina, (1925), on upper side of leaves, 19 June 1924, coll.: *V. Krajina,* PRC; Nízke Tatry (SLOVAKIA) – Bába Hill E of village of Lučivná, on petiole, 4 September 1920, coll.: *K. Domin,* PRC; **Eastern Carpathians** – Svidovets Mts. (UKRAINE) – Coluoirs in Limanovy car, 1650 m elev., 11 July 1931, coll.: *M. Deyl,* PRC.

Comments – *Wettsteinina dryadis* was noted in the Zachodnie Tatry Mts. and Belianske Tatry Mts. (Chlebicki 1995, 2002). It is a widespread species in Arctic and alpine regions, noted on *Dryas octopetala, D. drummondii* and *D. integrifolia* (Shoemaker & Babcock 1987).

Biogeographic connections

No doubt the old host plant metapopulation was widely distributed in the Carpathians during the last glaciation. At present it is divided into separated areas. The sizes of the disjunct 'islands' inhabited by the host plant vary greatly. The number of fungus species of these 'islands' is distinctly connected with the size of the locality. Movement of fungi between the small host plant populations is very restricted, as indicated by the fungal data. Extinction of mycobiota in these 'islands' also is linked to their size, see also MacArthur & Wilson, (1963, 1967). Moreover, some very small host populations are inhabited by plurivorous fungi; the population from the Pieniny Mts. is one example. This distinct process of extinction makes it difficult to identify the origin of the host plant on the basis of mycogeographical analysis. It should be pointed out that *Dryas octopetala* tends to host a great number of arcto-alpine species of fungi (Chlebicki 2002). The presence of some alpine fungus species indicates the connection of Carpathian mycobiota with the Alps: *Crocicreas dryadis* var. *uniseptata*, '*Lachnum crystallophorum*', *Odontotrema alpinum* and *Acanthostigma longisporum*. So far these fungi were noted only in Central Europe, but Carpathian mycobiota possess species known from the Ural Mts. and Asia, such as *Leptosphaeria holmiorum*. Spore appendages of *Gnomonia drydis* are very similar to those from Scandinavia, not those from the Alps. The distribution of such species as *Odontotrema alpinum* and *Pleospora ascodedicata* indicates that there is a connection between the alpine

Table 1. Distribution of fungi in Carpathian 'island' areas*

Fungus	1	2	3	4	5	6	7	8	9	10	11	12	Total
Stomiopeltis dryadis	*	*	*	*	*	*	*	*	*		*		10
Crocicreas dryadis var. dryadis	*	*	*	*	*			*	*	*			8
Isothea rhytismoides	*	*	*	*	*				*	*		*	8
Leptosphaerulina dryadis	*	*	*	*						*	*	*	7
Gnomonia dryadis	*	*	*	*			*					*	6
Wettsteinina dryadis	*		*	*	*			*	*				6
Pseudomassaria islandica	*	*	*	*	*								5
Massarina balnei-ursi	*		*				*					*	4
Crocicreas variabile			*	*	*								3
Leptosphaeria dryadophila	*						*					*	3
Phaeosphaeria dryadea	*						*					*	3
Sphaerotheca volkartii	*		*									*	3
Sydowiella dryadis var. macrospora			*						*			*	3
Cainiella johansonii			*				*						2
Crocicreas dryadis var. uniseptata	*		*										2
Pleospora ascodedicata			*			*							2
Pseudomassaria minor	*		*										2
Acanthostigma longisporum			*										1
Lachnum crystallophorum												*	1
Leptosphaeria holmiorum	*												1
Melanomma margaretae			*										1
Mycosphaerella octopetalae											*		1
Mycosphaerella ootheca								*					1
Odontotrema alpinum					*								1
Otthia dryadis			*										1
Urceolella dryadicola												*	1
Lophiostoma winteri (n)			*				*					*	3
Mycosphaerella punctiformis (n)	*		*				*						3
Eurotium herbariorum (n)	*		*										2
Lophiostoma macrostomum (n)	*		*										2
Pleospora helvetica (n)								*				*	2
Protoventuria latispora (n)			*			*							2
Didymosphaeria massarioides (n)						*							1
Discosia strobilina (n)			*										1
Leptosphaerulina pulchra (n)								*					1
Massarina corticola (n)						*							1
Mycosphaerella tassiana (n)		*											1
Pleospora penicillus v. ambigua (n)			*										1
Scopinella solani (n)						*							1
Together	17	7	25	8	7	6	8	6	5	3	3	12	

***1** Malá Fatra Mts. **2** Chočské vrchy Mts. **3** Západné (Zachodnie) Tatry Mts. **4** Vysoké (Wysokie) Tatry Mts. **5** Belianske Tatry Mts. **6** Pieniny Mts. **7** Nízke Tatry Mts. (loc. Krakova hoľa) **8** Nízke Tatry Mts. (loc. Bába) **9** Svidovets Mts. **10** Chornohora Mts. **11** Maramureş, **12** Rarău Mts.

(n) fungi non-specific for *Dryas*

mycobiota in Central Europe and in Scandinavia. The presence of the various fungi mentioned earlier indicates that the *Dryas octopetala* population in the Carpathians probably is composed of elements of various origin.

Table 2. Distribution of specific and plurivorous fungi in the Carpathians

Region	Dryas-specific fungi	Plurivorous	Area-specific species	Size of host population area
Malá Fatra Mts.	14	1	1	+++
Chočské vrchy	6	1		++
Západné (Zachodnie) Tatry Mts.	18	7	3	++++
Vysoké Tatry Mts.	8			++
Belianske Tatry Mts.	7		1	+++
Pieniny Mts.	2	4		+
Nízke Tatry Mts. (loc. Krakova hoľa)	6	2		++
Nízke Tatry Mts. (loc. Bába)	4	2		+
Svidovets Mts.	5			++
Chornohora Mts.	3			+
Maramures	3			+++
Rarâu Mts.	10	2	2	+++

The fungi can be divided into three groups: 1 – arcto-alpine specific fungi noted in some 'islands'; 2 – rare specific fungi noted in single localities; 3 – fungi non-specific for *Dryas* (Table 1). In almost all 'island' areas, the following *Dryas*-specific fungi were found: *Isothea rhytismoides, Crocicreas dryadis* var. *dryadis, Stomiopeltis dryadis* and *Leptosphaerulina dryadis* (Table 1). Of these, only *Crocicreas dryadis* var. *dryadis* is exclusively a European species. Non-specific dryadicolous fungi (Table 2) were found in the Zachodnie Tatry Mts. (mostly arcto-alpine species) and Pieniny Mts. (mostly plurivorous species). In this last locality the host plant grows at 715 m elev., which is its lowest locality in the Carpathians.

Some connection between particular 'islands' were noted. The presence of *Pleospora ascodedicata* in the Tatry Mts. and Pieniny Mts. only, as well as the presence of *Cainiella johansonii* in the Tatry Mts., Liptovské hole and Nízke Tatry Mts. evidence a connection between these areas in the past. In terms of mycobiota, the 'islands' most similar to each other were the Malá Fatra Mts., Chočské vrchy Mts., Západné (Zachodnie) Tatry Mts., Vysoké Tatry Mts. and Bielanske Tatry Mts. The four big 'islands' possess exclusive species (Table 2). Among them, the Západné (Zachodnie) Tatry Mts. are the most distinct and separated 'island', having a greater number of exclusive species and a single endemite, *Melanomma margaretae*. However the dispersion of the fungi in smaller 'islands' is mostly accidental, the result of the decline of the host plant population and the consequent extinction of fungi.

These data should be augmented with more and wider mycogeographical analyses.

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Four new lichen species from Turkey

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Abstract—Four species of lichenized fungi, *Lecidea variegatula*, *Lecidella anomaloides*, *Ramalina subgeniculata* and *Verrucaria compacta*, are newly recorded for Turkey; for each, a taxonomic description, together with habitat and distributional data, is provided.

Keywords— Ascomycetes, Bayburt, Biodiversity, MustafaKemalpaşa

Introduction

Although the lichen flora of Turkey is largely unknown and many regions of this country have yet to be investigated, in recent years there has been a substantial increase in the attention paid to this country (Aslan 2000, Aslan and Öztürk 1994, Aslan et al. 1998, 2002a, b, Gönülol et al. 1995, Öztürk and Kaynak 1999, Öztürk 1990, Özdemirtürk 2003, Yazıcı and Aslan 2002a, b, Yazıcı 1995). John (1996a, b) has reviewed the earlier work and provided an invaluable checklist on which to build our knowledge. The present paper is a further contribution to this work.

Material and methods

Samples were collected from two different stations in Bayburt and Bursa province in July-August 2003. A stereo microscope, a light microscope and the usual spot tests were used in the identification of the samples, together with the following reference books: Clauzade & Roux (1985), Poelt (1974), Purvis et al. (1992) and Wirth (1995). Vouchers have been deposited in the herbarium of the Biology Department, Fatih Education Faculty, Karadeniz Technical University.

Results

Lecidea variegatula Nyl.

Thallus episubstratic, large or small, 1,5-3 mm thick, subsquamulose, areolate; surface yellowish white, brownish yellow, grey or brown; not sorediate, without thalloconidia; areoles/lobes angular or rounded, plane or convex, folded, continuous throughout the thallus, basally not constricted or basally constricted; edges concolorous with the remaining areoles/lobes surface. Ascomata 80-400 per cm^2, 3-9(-1.3) mm in diam., sessile, slightly constricted at the base; disc plane or weakly convex to rarely distinctly convex, black, not pruinose; margin persistent, not flexuose, not pruinose, not umbonate; excipulum 20-50 μm wide, grey, without to with parallel-radiate hyphae, hyphae 3-5 μm wide; hypothecium hyaline; hymenium 25-40 μm high, hyaline to greenish hyaline; epihymenium olivaceous to green to turquoise, HC- to + bluish; ascospores ellipsoid to ellipsoid-cylindrical, (4.5-)5-7.2(-8) μm long, (2-)2.4-2.8(-3.5) μm wide, smooth; conidia (3.5-)4.6-5.1(-6) μm long. Medulla K-, C-, PD-; ascomatal disc C-; excipulum K-, C-; hypothecium K-; epihymenium K-.

On non-calcareous rock (sandstone, rarely with traces of carbonate) in well-lit areas. It is distributed throughout Europe and South America.

Bursa: MustafaKemalpaşa, near Suuçtu Cascade, on slightly calcareous rock, at 600 m altitude, 39° 53’ 00” N, 28° 19’ 00” E, 24 August 2003.

Lecidella anomaloides (A. Massal.) Hertel & Kilias

Thallus, thin (0.2 mm thick), crustose, continuous to indistinctly areolate, ± scurfy to ± granular, wide-spreading, pale to dark grey or greenish; hypothallus usually absent (rarely visible at the thallus margin, up to 0.1 mm thick), black. Apothecia sparse or moderately abundant, 0.4-0.7 mm in diam., sessile, flat to slightly convex and slightly constricted at the base; disc plane, black, not pruinose; margin biatorine; excipulum well developed, often wavy, persistent, 50-70 μm thick, mostly opaque, dark brown towards the hypothecium; epithecium green-black to brownish, non-crystalline; hypothecium hyaline, colourless or pale brown, red brown when old and often K+ faintly reddish; hymenium hyaline, not inspersed; paraphyses not (or rarely) distinctly branched, not (or rarely) anostomosing; not (or slightly) thickened; ascospores 8 per ascus, ellipsoid or ovoid, 9-15 x 7-8 μm; conidiophores of Vobis-type III: conidia filiform or curved.

On shaded, often vertical, ± damp, siliceous rocks, often in wooded situations or in sheltered gullies. It is distributed throughout Western Europe, from the Mediterranean northwards, and in North America.

Bursa: MustafaKemalpaşa, near Suuçtu Cascade, on calcareous rock, at 600 m altitude, 39° 53' 00" N, 28° 19' 00" E, 24 August 2003.

Ramalina subgeniculata Nyl.

Thallus shrubby, 1-5 cm high, generally with numerous branches; lobes up to 2-5 mm wide, longitudinally furrowed, perforate and fenestrate; medulla P-, K-, C- and KC-, without pseudocyphellae and soralia. Apothecia frequent, apical, subapical and lateral, often spurred; ascospores 9-16 x 4-6 μm and quite curved.

On non-calcareous rocks or deciduous trees exposed to light but sheltered against wind; generally found in the Mediterranean area and Madeira.

Bursa: MustafaKemalpaşa, near Suuçtu Cascade, on calcareous rock, at 600 m altitude, 39° 53' 00" N, 28° 19' 00" E, 24 August 2003.

Verrucaria compacta (A. Massal.) Jatta

Thallus dark brown, clearly areolate; areoles contiguous or occasionally solitary, irregular, thick, widening from a narrower base (subumbilicate), and therefore ± easily detatched from rock, mostly ending abruptly but occasionally with a few smaller, flatter marginal areoles, in section appearing compound above but with thick, white, ± continuous medulla; hypothallus not evident; ascomata completely immersed, with small, black nearly invisible ostioles; ascomatal wall colourless except at the mouth; ascospores (9-)11-18 x 6-9(-11)μm.

On calcareous rock in alpine areas of Europe.

Bayburt: Yeniköy, on calcareous rock, at 2500 m altitude, 40° 03' 45" N, 40° 10' 10" E, 2 July 2003.

Discussion

In this study four lichen species are presented, which are new records for the lichen flora of Turkey. In previous work conducted in the region, Yazıcı (1999a) reported 78, Yazıcı (1999b) 231, and Yazıcı and Aslan (2003) 206 lichen species. The climate of MustafaKemalpaşa (Bursa) is mild and cool in summer, being intermediate between continental and cool Mediterranean. Below 400 m the dominant vegetation type is Macchia. Between 400 and 700 m forest appears, especially by streams, mostly *Pinetum, Quercetum* and *Carpinetum.* Large areas have been converted into prairies. MustafaKemalpaşa is rich in fruticose and crustose lichen species. Bayburt has a continental climate with severe winters and hot summers; it is quite poor in terms of forest cover, being very rich in crustose but poor in fruticose lichen species.

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Nectriella guadalupensis **and Its** ***Dendrodochium*****-like anamorph (*****Bionectriaceae, Hypocreales*****): a new species on** ***Agavaceae***

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Abstract—*Nectriella guadalupensis* and its *Dendrodochium*-like anamorph are described from dead leaves of *Nolina*. A *Dendrodochium*-like anamorph is new for the genus *Nectriella*.

Keywords—Ascomycotina, *Nolina*, systematics

Introduction

The *Hypocreales* are distributed worldwide but favor tropical and warm-temperate locales. Members of the order exhibit a nutritional status from apparent saprotrophy to biotrophy in some stage of developmental. These fungi are found on a wide variety of biotic substrata including both animals and plants. In addition, several genera or species within a genus occur on lichens or are fungal associates on polypores, mushrooms, discomycetes, ascomycete stromata, and myxomycetes (Rossman et al. 1999).

Farr et al. (1989) list two hypocrealean genera from *Yucca* L., *Hyponectria mohavensis* Bonar, and *Allantonectria yuccae* Earle. No member of the Hypocreales is cited from other members of the Agavaceae commonly found in southwestern deserts in the USA, *Agave* L., *Nolina* Michx., or *Dasylirion* Zucc. *Hyponectria* Sacc. was moved from the *Hypocreales* to the *Phyllachorales, Physosporellaceae* (Barr 1977) and is now placed in the *Xylariales, Hyponectriaceae* (Barr 1990). *Hyponectria mohavensis* was excluded from the genus (Barr 1977), but its proper disposition was not determined. *Allantonectria yuccae* Earle is a synonym of *Nectria miltina* (Mont.) Mont. (Rossman et al. 1999). In addition to the *Yucca* substratum, this fungus has now been collected on *Dasylirion* and *Nolina* (Rossman et al. 1999), and more recently on *Agave* in the USA. Two other members of the *Hypocreales* have been described from leaves of the Agavaceae (Ramaley 2001). *Niesslia agavacearum* A.W. Ramaley, found on *Dasylirion* and less frequently on *Nolina*, is a member of the *Niessliaceae*. *Hyaloseta nolinae* A.W. Ramaley from *Nolina* was tentatively placed in the *Niessliaceae* on morphological grounds despite its having hyaline ascomatal setae. DNA sequencing has shown it is similar to other members of the *Niessliaceae* (Amy Rossman, personal communication).

Nectriella Nitschke comprises 23 species of the *Bionectriaceae* in the *Hypocreales* (Rossman et al. 1999). The genus was redescribed and known species described and illustrated by Lowen (1991) who also removed several lichenicolous species formerly classified as *Nectriella* to *Pronectria* Clem. Additional *Nectriella* species were described, and a key to all the species was provided by Rossman et al. (1999). *Nectriella* is distinguished from other family members by its non-stromatic ascomata, and its immersed to partially erumpent habit in wood, bark, and herbaceous tissues, or rarely, lichens and fungi. Ascospores are 1-septate except in *Nectriella jucunda* (Durieu & Mont.) Sacc., which has aseptate ascospores. *Nectriella pironii* Alfieri & Samuels causes stem galls and cankers in several ornamental plants (Alfieri et al. 1979), whereas other species are saprotrophes. Anamorphs are known for few *Nectriella* species. *Acremonium* Link. or *Acremonium*-like fungi are anamorphs of *N. minuta* Lowen, *N. dakotensis* (Seaver) Lowen (as *N. muelleri* Samuels et al. in Samuels et al. 1984) and an unnamed species (Samuels et al. 1984). *Nectriella pironii* has a sporodochial *Kutilakesa pironii* Alfieri and a hyphomycetous *Acremonium*-like synanamorph (Alfieri & Samuels 1979). In this paper *Nectriella guadalupensis*, on dead leaves of *Nolina micrantha* I.M. Johnst., is described as a new species because it occurs on a novel substratum, the associated anamorph differs from any known for the genus, and the ascospores differ in size and shape from ascospores of any other species. *Nectriella guadalupensis* is similar to other hypocealean fungi in having an association with other fungal species. It is commonly seen with conidiomata of *Piptarthron sp.*, the fungus most often encounterd on *Nolina* leaves, and has also been found adjacent to *Coniothyrium sp.* conidiomata. Ascomata are found adjacent to old conidiomata or even in the mouth of such structures. In addition to these associates, all stages of *N. guadalupensis* are associated with pale orange, *N. guadalupensis*-like hyphomycete hyphae that bear gray to gray-brown dictyospores.

Materials and Methods

To obtain cultures, *Nectriella* ascomata were divested of as much surrounding tissue as possible, rinsed three times in sterile tap water, and cut open to release groups of asci. Droplets containing groups of asci and freed ascospores were placed in drops of sterile tap water on Petri plates of commercial potato dextrose agar (PDA, BBL) + 2% agar (Difco) + ca 2.5 mg L streptomycin, and spread with a sterile glass rod. Germination from free ascospores occurred within 48 h. Germlings were transferred to PDA tubes and maintained at room temperature (RT, 18–22 C) in incident daylight. Sections were cut with a razor blade and mounted in tap water for examination. Measurements were made using an ocular micrometer with 0.8 µm increments. Growth rate was established by touching a sterile needle to conidia in an actively growing culture and stabbing the center of a PDA plate. Plates were wrapped in laboratory film and grown at RT in incident daylight on a tabletop. Each week, colonies were measured to the nearest mm.

Taxonomic Description

Nectriella guadalupensis A.W. Ramaley *sp. nov.* **FIGURES 1-6**

Ascomata singulares vel pauci-aggregata, immersa in conidiomatibus veteribus fungorum (Piptarthron, Coniothyrium), proxime extra conidiomata fungorum talium, vel in fissura *stomatiphora, obpyriforma 150–200 µm lata, 200–280 (–360) µm elata, dilut-aurantiaca maturitatem; papilla 64–120 (–200) µm, apex expositus, truncatus, canalis ostioli periphysatibus. Peridium 16–24 µm latum, strata externa cellularum crassi-parietibus composita, strata interna cellularum elongatarum tenui-parietibus composita, strata extima ascomatum insularum cellularum bruni-parietibus composita ex hyphis ambientibus formata. Asci cylindrici-clavati, 40–60 (–70) X 6.4–8.8 µm, apex rotundatus. Ascosporae allantoideae vel interdum prope cylindricae, (8–) 9.6–11.2 (–12.4) X 2–2.4 µm, in medio 1-septatae, non constrictae ad septa, hyalinae, laeves.*

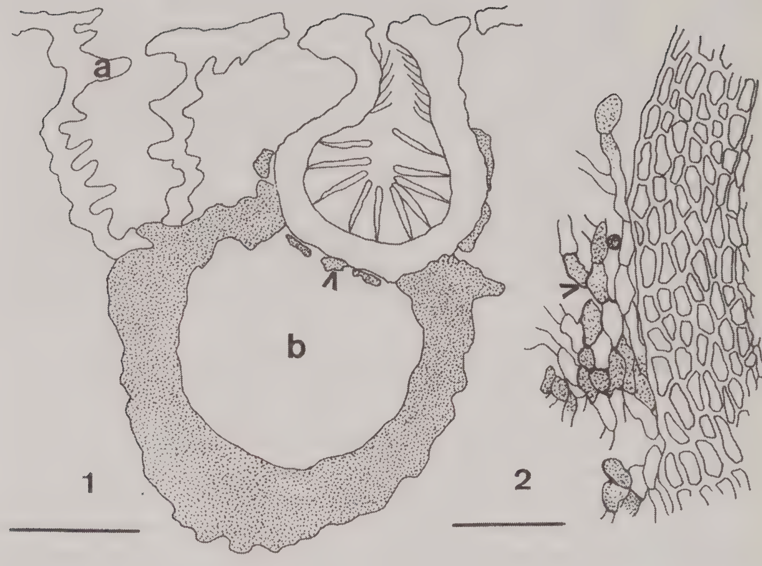
Anamorph: *Dendrodochium*-like

HOLOTYPE: USA. TEXAS: Culberson County, Guadalupe Mountains National Park, 4.6 miles from the highway gate on Williams Ranch Road, 20 October 1999, often associated with other fungi (*Piptarthron*, *Coniothyrium*, undetermined hyphomycete genus) on dead leaves of *Nolina micrantha* I. M. Johnst., Annette Ramaley 9912A, culture CBS 110134 (BPI 842102. Isotype: UC).

Ascomata single or in small groups, immersed in old conidiomata of other genera (*Piptarthron*, *Coniothyrium*), immediately external to such conidiomata, or with anamorph in stomatal cleft of substratum, obpyriform, 150–200 µm broad, 200–280 (–360) µm tall, at maturity pale orange; papilla 64–120 (–200) µm tall, deeper orange than venter, truncate tip exposed, ostiolar canal lined with periphyses. **Peridium** 16–24 µm thick, most layers composed mainly of small, thick-walled cells, a few innermost layers composed of more elongate, thinner-walled cells sometimes present; external to these wall layers, ascomata eventually surrounded, with gaps, by islands of irregularly shaped, brown-walled cells differentiated from hyphae surrounding ascomata. Wall of papilla usually with a few layers of thick-walled, rounded cells externally, and elongate thin-walled cells internally. **Asci** unitunicate,cylindric-clavate, 40–60 (–70) X 6.4–8.8 µm, apex rounded, apical ring not observed, interthecial elements lacking. **Ascospores** allantoid to nearly cylindric, (8–) 9.6–11.2 (–12.4) X 2–2.4 µm, 1-septate in middle, not constricted at septum, hyaline, pale orange en masse, smooth.

Conidiomata sporodochial, narrow at base, broadening toward conidiomatal surface, pale orange when active, ca 160 µm broad, much extended along stomatal clefts of affected leaves up to at least 3 mm, apparently by fusion of adjacent conidiomatal initials, hyphae upright, repeatedly branched, each penultimate cell bearing 2 or 3 conidiogenous cells. Conidiogenesis phialidic, phialides 7.2–9.6 X 2–2.4 µm, lageniform, with short collarette and some periclinal thickening, pale orange. Conidia usually bacillar, 4–7.2 X 1.6 µm, individually hyaline, pale orange in mass, smooth, thin-walled, biguttulate.

Growth in Culture — On PDA, mycelium white to pale orange, tightly appressed to agar, hyphae more widely separated below agar surface. After 1 w, colonies 5–8 mm diam (avg. 6.0 mm), some colonies developing an orange center. After 2 w, colonies 13–16 mm diam (avg. 14 mm), all with bright orange center surrounded by a white marginal ring 4–6 mm broad. Slimy orange central spot somewhat raised, consisting of vegetative hyphae 0.8–1.6 µm diam, hyphae ca 2.5 µm diam bearing expanded, curved conidiogenous cells 2–3.2 X 8–12 µm, and conidia. Orange from accumulated conidia and conidiogenous cells. Conidiogenous cells born laterally on hyphae, or terminally with 2 to 3 conidiogenous cells born on a penultimate cell. Closely spaced branching reminiscent of sporodochia only rarely present in broader hyphae below

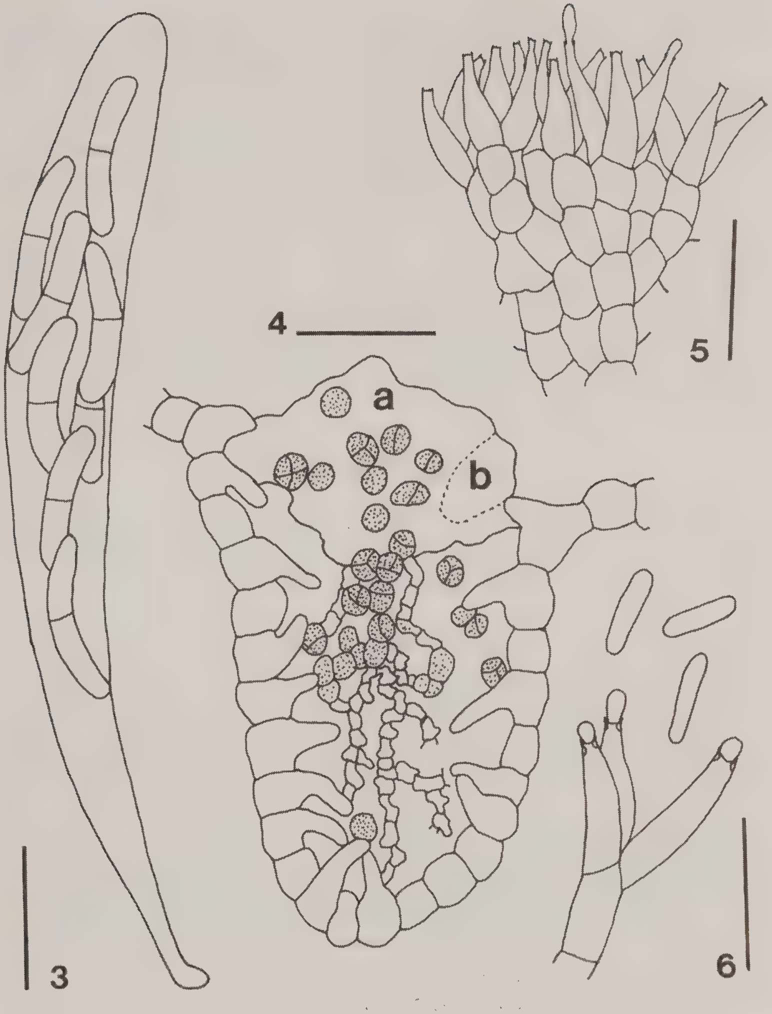


Figs. 1–2. *Nectriella guadalupensis*. 1. Transection of *Nolina* leaf with ascoma in mouth of old *Piptarthron* conidioma. (a), tooth of epidermal cell in stomatal cleft; (b), locule filled with *Nectriella* hyphae; (>), islands of brown-walled cells that develop from hyphae surrounding an ascoma. 2. Wall of ascoma; (>), brown-walled cells in island adjacent to ascoma. Lines: Fig. 1 = 100 μm; 2 = 20 μm.

terminal conidiogenous cells. Conidiogenesis phialidic, phialides with slight periclinal thickening and short collarette. Conidia mostly bacillar 4–6.4 X 1.6 μm, hyaline, smooth, thin-walled, biguttulate. After 4 w colonies 31–34 mm diam (avg. 33 mm). Appearance of colonies much as in young cultures, orange center surrounded by a ring of white hyphae. In older cultures, central orange spots form radii from small orange foci of conidium production which expand and fuse. In addition, hyphae below agar also form conidiogenous cells and conidia.

Discussion

Nectriella guadalupensis is distinguished from other species by its occurrence in the desert, habitat on dead leaves of *Nolina*, a monocot, the allantoid to cylindric ascospores, and the *Dendrodochium*-like anamorph. Other species with monocot substrata include *Nectriella dacrymycella* (Nyl.) Rehm on stems of *Iris* Tourn. *ex* L., *N. exigua* Dennis from *Ammophila* Host., *N. curtisii* (Berk.) Lowen on stems of *Typha* L., *N.paludosa* Fuckel from stems of *Typha* and *Iris*, and *N. minuta* Lowen from dead bamboo culms. Ascomata of *N. exigua, N. curtisii,* and *N. minuta* generally remain immersed, as do those of *N.guadalupensis*, but the substrata for these other species are not xerophytic. *Nectriella* ascospores are usually ellipsoid to ellipsoid-fusiform to fusiform. As in *N. guadalupensis, N. jucunda*, from stems of *Opuntia* Tourn. *ex* Mill., has allantoid to cylindric ascospores, but they are aseptate and only ca 5.5 μm long.



Figs. 3–6. *Nectriella guadalupensis*. 3. Ascus and ascospores. 4. Diagram of conidioma (a) in stomatal cleft, and distribution of dictyospores of associated hyphomycete. 5. Detail of portion of conidioma from Fig. 4 (b). 6. Conidia and terminal conidiogenous cells in culture. Lines: Fig. 3 = 10 μm; 4 = 40 μm; 5, 6 = 8 μm.

On its substratum, the *Dendrodochium*-like anamorph for *N. guadalupensis* is easily distinguished from other *Nectriella* anamorphs. Conidiogenous cells are born on sporodochia, not separately, as are *Acremonium* conidiogenous cells. These sporodochia lack setae such as those occurring on *Kutilakesa pironii* sporodochia. In addition, *K. pironii* has an *Acremonium* synanamorph that is more common than the sporodochia in cultures as well as in nature. Typical *Dendrodochium*-like sporodochia are lacking in *N. guadalupensis* cultures, but conidium formation has never been observed on separate, upright, *Acremonium*-like conidiophores. The *Dendrodochium*-like anamorph is also distinct from the sporodochial, non-setose genus *Tubercularia* Tode that often has acropleurogenous phialides, conidiomata derived from a pseudoparenchymatous stroma, and rapid, pink growth in culture (Tulloch 1972, Seifert 1985).

The *Dendrodochium*-like anamorph could not be cultivated because few conidia were present, and propagules of many other fungal genera accumulate on the upper surface of the sporodochia on the decomposing leaves. However, the connection of the two states is supported by their organic connection on the host. In addition, conidia are produced on similarly shaped terminal conidiogenous cells that are born in twos or threes on the sporodochia on *Nolina* as well as in cultures from *Nectriella guadalupensis* ascospores.

Acknowledgements

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A host-specific species of *Hypoxylon* from France, and notes on the chemotaxonomy of the "*Hypoxylon rubiginosum* complex"

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Abstract—*Hypoxylon petriniae* sp. nov. is described from a new combination of morphological characters of its teleomorph and anamorph. It was found in France and other countries of Western and Central Europe, mostly colonising *Fraxinus excelsior*. Its status is supported by a chemotaxonomic study by analytical HPLC profiling with diode array and mass spectrometric detection of secondary metabolites in several *Hypoxylon* spp. These analyses revealed the presence of binaphthalene tetrol (BNT) as major stromatal metabolite of *H. petriniae*. This widespread purple stromatal pigment of *Xylariaceae* was not found in *H. rubiginosum, H. cercidicolum,* and further, presumably related species. In contrast to *H. rubiginosum* and *H. cercidicolum, H. petriniae* was found devoid of mitorubrin. Orsellinic acid and rubiginosins, which are recently identified azaphilone pigments chemically related to mitorubrin were found as common stromatal metabolites of many of the aforementioned taxa, and the occurrence of particular azaphilones appears to be specific for some species. A key to European *Hypoxylon* spp. is provided.

Key words—chemotaxonomy, systematics, secondary metabolites

Introduction

The current study deals with *Hypoxylon rubiginosum* (Pers. : Fr.) Fr. and presumably allied taxa. Miller (1961) had synominised about 60 names with *H. rubiginosum* in his world monograph, but many of them are now regarded as separate species. The work of Ju & Rogers (1996) helped very much to sort out this conglomerate of taxa. The authors gave detailed descriptions of type materials of several species and provided evidence that allowed to discriminate these morphologically related taxa. Nonetheless, the segregation of this "*H. rubiginosum* complex" appears to be still ongoing, as indicated by recent taxonomic treatments.

For example, there is a fungus associated with Fraxinus, which was reported as *H. rubiginosum* (Pers. : Fr.) Fr. var. *cercidicola* (Berk. & M. A. Curtis ex Peck) L. Petrini apud L. E. Petrini & E. Müller, by Petrini & Müller (1986). This variety was listed by Ju & Rogers (1996) among the synonyms of *H. cercidicolum* (Berk. & M. A. Curtis ex Peck) Y.-M. Ju & J. D. Rogers. According to Ju & Rogers (1996), the latter species was first described from Europe as *H. moravicum* Pouz. (Pouzar 1972). As pointed out by Granmo (1999), both Pouzar (1972) and Petrini & Müller (1986) already showed that *H. moravicum* differs from *H. rubiginosum* and its varieties with respect to teleomorphic and anamorphic characters. The asexual stage of the former species was described by Petrini & Candoussau (1983) as *Hadrotrichum pyrenaicum* Petrini & Candoussau. In contrast, cultures of *H. rubiginosum* var. *cercidicola* ss. Petrini & Müller (1986) were reported to produce an anamorph referable to *Virgariella* S. J. Hughes, which corresponds to the *Virgariella*-like branching pattern as defined in Ju & Rogers (1996). Moreover, the anamorph of this variety differs from that of *H. rubiginosum* ss. str., which forms on malt as well as oatmeal agar a conidiogenous structure of the *Nodulisporium* type ss. Ju & Rogers (1996). Granmo (1999) treated *H. rubiginosum* var. *cercidicola* as "*H. cercidicola* (Berk. & M. A. Curtis ex Peck) Y.-M. Ju & J. D. Rogers", albeit he explicitly stated that this fungus was not conspecific with *H. moravicum* ss. Pouzar (1972). Notably, Ju & Rogers (1996) described a fungus with morphological similarities to *H. rubiginosum* and a *Virgariella* anamorph from *Fraxinus* in their "Notes to *H. rubiginosum*". They even referred to a previous description of this *Virgariella*-like stage by Greenhalgh & Chesters (1968, as *H. rubiginosum*), but did not relate the similar description of *H. rubiginosum* var. *cercidicola* by Petrini & Müller (1986) to this taxon, for which they provided no new name.

In the current study, various specimens corresponding with the above taxa were collected fresh from France and studied for morphological characters of their teleomorphs and anamorphs. For comparison, some specimens that had been studied by Petrini & Müller (1986), as well as materials from Germany and the type of *H. suborbiculare* Peck were examined. High performance liquid chromatography (HPLC), which recently had revealed consistent species-specific differences in *Daldinia* Ces & de Not. (Stadler et al. 2001a,b), *Hypoxylon* (Mühlbauer et al. 2002; Hellwig et al. 2004) and allied *Xylariaceae* (Stadler et al. 2004) was employed to generate secondary metabolite profiles. Such data were used as surrogate parameters to verify morphological traits. Hence, we report the outcome of this study and erect the new species, ***H. petriniae* M. Stadler & J. Fournier**.

HPLC-based data were also correlated with morphological characters and data on KOH-extractable pigments to provide a user-friendly key that should allow specialists as well as amateur mycologists for identification of European *Hypoxylon* spp. This key is thus independent of HPLC-based data and anamorphic characters.

Materials and Methods

Specimens examined – Only those specimens examined for stromatal metabolites by HPLC are listed below. Most of them are representatives selected from an ongoing mycobiotic study on Pyrenomycetes of southwestern France, and several were also used in the concurrent study by Hellwig et al. (2004). Further materials examined by

J.F. and co-workers for morphological characters were listed on the Internet by Fournier & Magni (2004). If not indicated otherwise by acronyms of herbaria (following abbreviations as listed in Holmgren et al. 1990), the specimens are deposited at the mycological herbarium of the Fuhlrott-Museum, Wuppertal, Germany, and also kept in the personal herbarium of J. Fournier.

Albeit a great deal of culturing was involved (indicated as "CULTURED" for the materials in the list below), to verify the taxonomy of these species, not all strains remained viable. Surviving cultures were deposited at CBS (where indicated) and/or at the collection of the Academia Sinica, Taipei, Taiwan and preserved at the Bayer Pharma Research Center, Wuppertal, Germany, on YMG agar slants at 4°C and in liquid N_2.

REMARKS: (*,#): Specimens consisting of (*) two or even (#) three different species growing on the same substrate, which were discriminated by examination of teleomorphic, anamorphic and cultural characters, as well as by HPLC profiling of stromatal extracts. With these materials, extraction and culturing experiments were repeated several times to exclude dependence of results on substrate and environmental factors. – (**) Further materials of these species were previously examined by Mühlbauer et al. (2002) and their HPLC data are considered in the current study. Acronyms of collectors: JF: Jacques Fournier; STMA: Marc Stadler; Ww: Hartmund Wollweber. Materials from ZT were generally included in the study by Petrini & Müller (1986).

Hypoxylon cercidicolum (Berk. & M.A. Curtis ex Peck) Y.-M. Ju & J.D. Rogers: FRANCE. Ariège: RIMONT, Las Muros, *Fraxinus excelsior*. 20.X.2001, *JF-01129*, CULTURED. – UNITED STATES. New York: SANDLAKE, 1877, corticated wood of *Fraxinus*, C.H. Peck (NYS, TYPE of *Hypoxylon suborbiculare* Peck, nom. illeg.).

H. ferrugineum Otth: **SWITZERLAND: Zürich,** WÄDERSWIL, Autumn 1972, *Sorbus aucuparia* var. *edulis*, J. Anliker as *H. rubiginosum*, det. E. Müller (ZT).

H. fragiforme (Pers. : Fr.) J. Kickx fil.**: **GERMANY. Rheinland-Pfalz Prov.:** KARLSTAL, near TRIPPSTADT, on recently felled trunk of *Quercus robur*, 28.IX.2003, *STMA 03044*, CULTURED, CBS 115276. – dto., twigs of *Fagus sylvatica*, 28.IX.2003, *STMA 03045*, CULTURED, CBS 115275.

H. howeianum Peck**: **FRANCE. Ariège**: RIMONT, Las Muros, *Quercus robur*, 10.VII.1996, *JF-96050*.

H. intermedium (Schwein. : Fr.) Y.-M. Ju & J. D. Rogers: **FRANCE. Ariège:** RIMONT, Las Muros, *Fraxinus excelsior*, 27.VII.2003, *JF-03128*, CULTURED, CBS 115274. – **Pyrénées Atlantiques**: OLORON, Forêt de Bugangue, *Fraxinus*, 15.X.1981, L. & O. Petrini & F. Candoussau, as *H. fraxinophilum* (ZT). – **LIECHTENSTEIN.** GAMPRIN, Rheinau, 27.IX.1986, *Fraxinus*, L. & O. Petrini, as *H. fraxinophilum* (ZT). – **SWITZERLAND. Zurich:** FÄLLANDEN, forest near Benglen, Müliholz, *Fraxinus*, 02.X.1984, L. Petrini, as *H. fraxinophilum*.

H. julianii L. E. Petrini: **FRANCE**: **Ariège,** MONTSERON, Roquebrune, decorticated wood of *Salix caprea*, 04.VI.1999, *JF-99112*. – **SWITZERLAND. Graubünden:** SOLAS near FILISUR, *Alnus incana*, 03.IX.1982, L. Petrini (ZT-HOLOTYPE). – dto., *Alnus incana*, 24.IX.1983, L. & O. Petrini (ZT-PARATYPE).

H. laschii Nitschke: **FRANCE. Ariège:** RIMONT, Saurine, *Populus tremula*, 09.VIII.1998, *JF-98096*.

H. petriniae M. Stadler & J. Fournier, sp. nov.: Specimens see taxonomic part (**B**) of Results and Discussion.

H. perforatum (Schwein. : Fr.) Fr.: FRANCE. Ariège: RIMONT, Las Muros, *Fraxinus excelsior*, 02.IX.2000, *JF-00181*, CULTURED, CBS 115281. – dto., *Rhamnus carthartica*, 27.VII.2003, *JF-03125*. – dto., *Fraxinus excelsior*, 27.VII.2003, *JF-03126*. – dto., *Fraxinus excelsior*, 16.VIII.2003, *JF-03139C*#, CULTURED. – Isère: region of Lac de PALADRU, ca. 0.8 km SE of PALADRU, edge of Marais de la Véronnière, on decorticated fallen branch of *Fraxinus*, 29.VIII.2003, D. Triebel & G. Rambold *G.R.-9571* (M), associated with *H. petriniae*, CULTURED. – Pyrénées Atlantiques: NAY, Saligues de Bourdettes, *Fraxinus*, 12.X.1981, F. Candoussau & L. Petrini as *H. rubiginosum* var. *perforatum* (ZT). – SWITZERLAND. Jura: ST. URSANNE, Col de la Croix, cf. *Carpinus betulus*, 19.VI.1983, L. & O. Petrini, as *H. rubiginosum* var.

perforatum (ZT). – Tessin: Meride, *Fraxinus*, 26.VII.1982, L. Petrini & A.J.S. Whalley, as *H. rubiginosum* var. *perforatum* (ZT).

H. rubiginosum (Pers. : Fr.) Fr.**: FRANCE. Ariège: RIMONT, Las Muros, bark of *Populus tremula*, 21.VIII.1999, *JF-99191*. – dto., *Fraxinus excelsior*, 02.IX.2000, *JF- 00180B**; CULTURED. – dto., 07.IX.2001, decorticated wood of *Ulmus*, *JF 01189*, CULTURED. – dto., *Fraxinus*, 15.VI.2003, *JF- 03100B**, CULTURED. –dto., *Fraxinus excelsior*, 16.VIII.2003, *JF-03139B*#, CULTURED. – USTOU, Cirque de Cagateille, decorticated wood of *Fagus*, 26.VIII.2001, *JF-01173*, CULTURED. – Isère: region of Lac de PALADRU, ca. 0.8 km SE of PALADRU, edge of Marais de la Véronnière, decorticated fallen branch of *Fraxinus*, 29.VIII.2003, D. Triebel & G. Rambold *GR-9575* (M), associated with *H. petriniae* and *H. perforatum*, CULTURED, CBS 115160. – GERMANY. North Rhine Westphalia Prov.: HAAN-GRUITEN, Neandertal, bark and wood of *Fraxinus excelsior*, 16.IV.2003, STMA & Ww, *Ww 4314*, CULTURED. –SWITZERLAND. Graubünden: Station UNTERVAZ, Heurütenen, decorticated wood, 31.VII.1982, L. Petrini & A.J.S. Whalley (ZT). – Bern: Brünigpasshöhe, *Fagus sylvatica*, 18.X.1982, L. Petrini (ZT) – Tessin: SAGNO, San Martino, *Fraxinus excelsior*, 26.VII.1982, L. Petrini & A.J.S. Whalley (ZT) – Zurich: ZURICH, Albisguetli, bark of *Fraxinus excelsior*, 05.XI.1981, T. Sieber, det. L. Petrini as *H. rubiginosum* var. *rubiginosum* (ZT) – UNITED KINGDOM. Devon: MANATON, Becky Falls, Houndtor wood, *Salix*, 21.IV.1982, L. Petrini (ZT).

H. rutilum Tul. & C. Tul.: FRANCE. Ariège: RIMONT, Las Muros, *Prunus avium*, 11.IX.2000, *JF-00291*, CULTURED, CBS 115159.

H. subticinense Y.-M. Ju & J. D. Rogers: **FRANCE. Ariège:** RIMONT, Las Muros, *Populus tremula*, 26.V.1997, *JF 97075*. – dto., ruisseau de Peyrau, *Rhamnus carthartica*, 28.VII.2000, *JF-00135*.

H. ticinense L. E. Petrini: **FRANCE. Ariège:** RIMONT, Las Muros, ruisseau de Peyrau, bark of *Fraxinus*, 02.IX.2001, *JF-01181*. – dto., Las Muros, *Malus silvestris*, 27.VII.2003, *JF-03124*. – dto., *Fraxinus excelsior*, 27.VII.2003, *JF-03129*, CULTURED, CBS 115271.

Microscopic observations of teleomorphic structures were made in water (for studying ascospore morphology), in Melzer's reagent (for testing the amyloidity of ascal apical structures), in aqueous Congo Red, Blue Black Waterman ink or Phloxine (for measurements of ascal stipes), and in 10% KOH for testing the dehiscence of perispore. Measurements of ascospores were taken in water at 1000x magnification. KOH-extractable pigments were obtained as described in Ju & Rogers (1996). Colour codes follow Rayner (1970). The conidiogenous structures and all species treated here are named, following the monograph by Ju & Rogers (1996) and the recent update by Ju et al. (2004), respectively. Microphotographs of ascospores were taken in Melzer's reagent. **SEM** (scanning electron microscopy) of ascospores was carried out as described previously by Stadler et al. (2002). **Microscopic observations of anamorphic structures** were made in water at 400x - 1000x magnification, using phase contrast. For this purpose, cultures were obtained from single ascospores in a similar manner as described by Petrini & Müller (1986), transferring the germinated spores to a yeast-malt glucose (YMG) medium supplemented by antibiotics (Stadler et al. 2001a). For morphological studies, the cultures were grown on malt agar (Petrini & Müller 1986) as well as on Difco Potato dextrose (PDA), YMG and Difco Oatmeal agar (OA) to compare morphological structures to all previous reports. No significant differences regarding the shape and size of conidiogenous structures were seen in the same fungus grown on different media. However, macroscopic characteristics of the culture were influenced by the medium, and to assure conformity with the reports by Ju & Rogers (1996), the photographs shown in Figs. 7 – 8 were taken from OA, the medium generally used by the latter authors.

HPLC analyses of stromatal methanolic extracts were carried out according to Mühlbauer et al. (2002) in two different gradients, using UV-visual detection (**HPLC-**

UV/Vis) with diode array detection (**DAD**) and mass spectrometric detection (**HPLC-MS**) in both the positive and negative electrospray ionisation (**ESI**) mode. Secondary metabolites were identified by matching their retention times (**Rt**), HPLC-UV/Vis and HPLC-MS spectra with external or internal standards of pure compounds that had been obtained previously and concurrently. HPLC data of extracts and pure compounds from previous studies on *Xylariaceae* (Hellwig et al. 2004, Quang et al. 2002, 2004a,b, Stadler et al. 2001a,b, 2004) were also used for comparison. Cultures were propagated on YMG medium, and their extracts analysed on the occurrence of secondary metabolites as described by Stadler et al. (2001a). Some materials from Difco OA plates were also extracted with ethyl acetate or methanol and their extracts analysed for comparison.

Results and Discussion

The results of the current study are divided into a chemotaxonomic and a morphological/ taxonomic part, both of which are presented and discussed separately.

A. HPLC-based studies on secondary metabolites

Secondary metabolites have been known to be valuable in the taxonomy of *Xylariaceae* for a long time. For instance the secondary metabolites of cultures are specific for particular genera to some extent (Whalley & Edwards 1995, Stadler et al. 2001a,b, 2004). Stromatal pigment patterns of *Hypoxylon* in particular are known to be species-consistent. They even revealed characteristic differences between taxa that were at times only regarded as "chemical races" of the same species (Whalley & Greenhalgh 1971, Whalley & Whalley 1977), but whose status as separate taxa has meanwhile been established by morphological methods. These early studies dealt with thin layer chromatography (**TLC**), a technique which provides insufficient information, especially if standards of the detected metabolites are not available. HPLC coupled with spectral techniques provides a higher sensitivity and resolution, and the characteristic compounds contained in fungal materials can be safely identified, using only some mg of crude material (Stadler et al. 2004).

In the current study, several *Hypoxylon* spp. were identified and examined as described in Materials and Methods. Methanolic extracts of their stromata were prepared and studied for the occurrence of characteristic secondary metabolites by analytical HPLC as previously described by Stadler et al. (2001a) and Mühlbauer et al. (2002). The results of this HPLC profiling study are summarised in Table 1, the chemical structures of characteristic metabolites depicted in Fig. 1 and some characteristic HPLC-UV chromatograms shown in Fig. 2. In accordance with previous chemotaxonomic studies on other *Xylariaceae*, the results were consistent for all species where several records were examined. The correspondence and synonymy of the species described by Petrini & Müller (1986) with their respective counterparts in the later monograph by Ju & Rogers (1996) was confirmed with one exception (***H. petriniae,*** see further below). The specimens obtained from ZT had all been collected prior to 1987, but still showed the same characteristic metabolites as the more recently collected specimens.

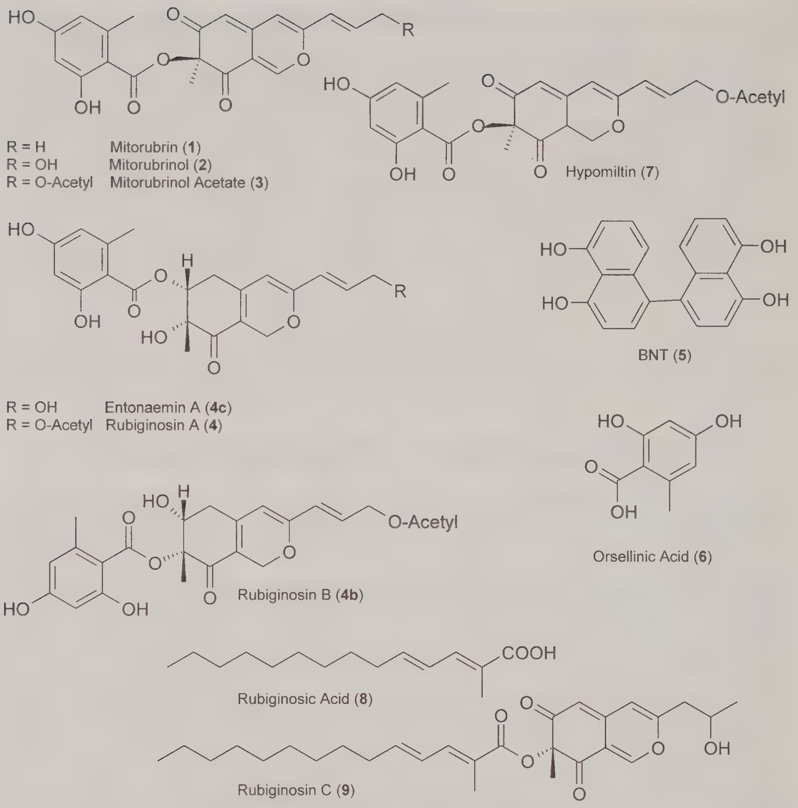

R = H Mitorubrin (1)
R = OH Mitorubrinol (2)
R = O-Acetyl Mitorubrinol Acetate (3)
Hypomiltin (7)
O-Acetyl
R = OH Entonaemin A (4c)
R = O-Acetyl Rubiginosin A (4)
BNT (5)
Orsellinic Acid (6)
Rubiginosin B (4b)
Rubiginosic Acid (8)
COOH
Rubiginosin C (9)

Fig. 1. Secondary metabolites detected in the current study. For distribution of these compounds in stromata of various *Hypoxylon* spp. see Table 2.

In most cases, age of specimens and seasonal aspects mainly affected the yields of secondary metabolites extracted (and thus, the intensity of the HPLC chromatograms) but not the composition of the secondary metabolite profiles themselves. Only very young conidiogenous stromata yielded rather small amounts of the characteristic compounds so long as no ascospores were formed. In such materials (which generally still have a yellowish surface colour), some unknown metabolites were also detected, even complicating the identification of the characteristic metabolites, but these were always present as deduced from HPLC-MS data. The latter technique is more sensitive (Stadler et al. 2004) and was successfully applied to depauperate specimens that had been collected in overmature state. Remarkably, these findings were in contrast to previous studies on *Daldinia* (Wollweber & Stadler 2001), where it had been easier to classify immature stromata at least with regard to their chemotype, since no apparently specific metabolites were observed in young conidiogenous stromata. Nonetheless, if ascospores were found besides the conidial stage, the stromata of the *Hypoxylon* spp. studied generally yielded larger quantities of extractable materials than aged and overmature ones. These findings were again in analogy to *Daldinia*.

The substrate did not apparently have any influence on secondary metabolite production. Even wood from the immediate vicinity of the stromata did not even show traces of those metabolites that were present in the stromata in abundance. This was not surprising, since the characteristic pigments of *Hypoxylon* are located in the outermost parts of the stromata, i.e., in regions that have no contact to the substrate. Hence, species-consistency of metabolite profiles was not only established with *H. rubiginosum*, colonising various hosts, but also, e.g., for an unusual collection of *H. fragiforme* from *Quercus robur* (STMA 03044), which did not differ from those specimens that were found on *Fagus*, the usual host of this species (cf. Mühlbauer et al. 2002, for similar findings on *H. fuscum*).

Among the taxa compared in the current study, ***H. petriniae*** was the only one containing BNT (**5**) as well as orsellinic acid (**6**) and the recently described compound, rubiginosin A (**4** in Fig. 1). The occurrence of the latter metabolite in *H. rubiginosum* (Mühlbauer et al. 2002) and several red- or yellow-pigmented species of *Entonaema* A. Möller (Stadler et al. 2004) had been previously established by comparing retention times (**Rt**) in two different gradient systems, as well as by HPLC-UV/Vis spectra and HPLC-MS characteristics in the positive and negative ESI mode. A typical HPLC chromatogram of *H. rubiginosum* and further species was also depicted in Mühlbauer et al. (2002). As demonstrated concurrently (Hellwig et al. 2004), there are further species of *Hypoxylon* in Asia and New Zealand that contain both compounds **5** and **6** as co-metabolites, but no other European taxon so far shared this feature. For details on the HPLC characteristics and other physico-chemical parameters we refer to these previous papers and to Quang et al. (2004a,b).

Rubiginosin A (**4** in Fig. 1) was still treated as "unknown compound **14**" by Mühlbauer et al. 2002) and now identified from *H. rubiginosum* (Quang et al. 2004b). This metabolite is structurally related to mitorubrins (**1** - **3** in Fig. 1) but the ester bond linking the orsellinic acid moiety to the azaphilone backbone is located at a different carbon atom, while the mitorubrins have a carbonyl group at this position (Quang et al. 2004b). While compounds **1** - **4** were found to co-occur in several *Hypoxylon* spp. (Table 1) as well as in all orange-pigmented species of *Entonaema* (Stadler et al. 2004), rubiginosin A (**4**) was not contained in *H. fragiforme* and *H. howeianum*, (Mühlbauer et al. 2002). As noted in the current study, it also lacked in *H. ticinense*. Additional minor metabolites of this type are the entonaemins (e.g. **4c**). They were reported from a fungus named *Entonaema splendens* (Berk. & M.A. Curtis) Lloyd collected in Japan (Hashimoto & Asakawa 1998), which may actually correspond with *E. cinnabarina* (Cooke & Massee) Lloyd (Stadler et al. 2004). The HPLC-UV and HPLC-MS data point toward their presence as minor metabolites in rubiginosin-containing *Hypoxylon* spp., due to the similar UV spectra and matching molecular masses observed.

Along with the novel fatty acid, rubiginosic acid (**8**) and rubiginosin C (**9**), an unprecedented compound that formally constitutes an ester of this acid with the modified azaphilone moiety of the mitorubrins, were identified as main constituents of *H. rubiginosum* from Germany. While the acid (**8**) was not detected in the current study, rubiginosin C (**9**) was found in several *Hypoxylon* spp. (see Table 2), including several species that also contained rubiginosin A (**4**). Presumably, these types of azaphilones are derived from different biogenetic precursors, and specific enzymes are necessary to modify the azaphilone backbone. There are even indications that further azaphilone esters of fatty acids may be present as specific lipophilic metabolites in various *Hypoxylon* spp., and their identification is currently pending.

All examined specimens of ***H. petriniae*** differed from both *H. rubiginosum* and *H. cercidicolum* by the presence of BNT (**5**) and the absence of mitorubrin (**1**). In contrast to the *H. cercidicolum* specimens (including *H. suborbiculare*), the two other species generally contained rubiginosin A (**4**) as common major metabolite. In *H. petriniae*, mitorubrin (**1**) was apparently replaced by an unidentified compound with rubiginosin-like HPLC-UV/Vis chromophore, which eluted at the same Rt as BNT. At least its characteristic molecular mass and the UV spectrum of mitorubrin were not detected, in contrast to the results obtained from other species. Entonaemin A (**4c**) and rubiginosin B (**4b**), whose structures are depicted in Fig. 1, were not detected in the crude extract and had only been isolated from *H. rubiginosum* in minor quantities after preparative HPLC separation (Quang et al. 2004b). The same work also revealed the presence of daldinin C in trace amounts in the stromata of *H. rubiginosum*, but this compound was also not detected during HPLC profiling of crude extracts.

Apparently, ***H. petriniae*** lacks the ability to produce mitorubrin, but can instead produce rubiginosin A/entonaemin-like azaphilones, rubiginosin C (**9**), and the purple pigment BNT (**5**). The latter compound is most probably responsible for its characteristic purplish to vinaceous stromatal surface colours that lack in, e.g., *H. rubiginosum*. Therefore, ***H. petriniae*** is quite easily distinguished from aforementioned, presumably related species by HPLC profiling. As shown below and in Table 2, these chemical traits are quite in agreement with various data available on the morphology and biology of this fungus. Conceivably, secondary metabolite profiles (and thus characters relating to KOH-extractable stromatal pigments as an important means of differentiation in the current generic concept) provide an important argument against the conspecificity of ***H. petriniae*** with *H. cercidicolum*.

Because ***H. petriniae*** occasionally co-occurs with other taxa on the same substrate, this phenomenon was studied by concurrent extractions and HPLC analyses of portions of stromata representing these different fungi. Albeit the stromata of two different *Hypoxylon* spp. were at times found growing only some centimetres apart from one another, their HPLC profiles were still found characteristic. The portions of the specimen JF-00180A, JF-03100A, JF-03139A and G.R.-9574 representing ***H. petriniae*** always contained BNT (**5**), while their counterparts representing *H. rubiginosum* and/or *H. perforatum* lacked this compound. In all cases, their stromata were found to contain the same metabolites as their counterparts that colonised the woody substrates alone. This was confirmed by repeating extraction and analyses several times for various portions of each specimen, as well as by concurrent culturing experiments.

As shown concurrently by Hellwig et al. (2004), the typical pigment of *H. hypomiltum* Mont., *H. intermedium* and *H. perforatum* is the yellow azaphilone hypomiltin (**7** in Fig. 1). All species found to contain this compound are apparently devoid of mitorubrins and rubiginosins (**1** – **4** and **9**). They can be discriminated without HPLC, since they yield greenish yellow pigments [e.g. amber (47), greenish yellow (16), citrine (13)] in KOH, while those of the species containing mitorubrin and/or rubiginin (cf. Table 1) are orange (7) or reddish brown.

Species of sect. *Hypoxylon* with yellow stromatal pigments in KOH also include *H. macrocarpum* Pouz. (Mühlbauer et al. 2002) and *H. fuscum* (Pers.: Fr.) Fr. (Quang et al. 2004b), both of which were recently found to contain compounds of the daldinin and macrocarpone types, respectively. These metabolites were not detected as major constituents in the species examined here. Neither were daldinal A, previously found as a minor metabolite in *H. fuscum*, and other, yet unknown metabolites of *H. subrutilum* Starb. (Mühlbauer et al. 2002).

In contrast, *H. laschii*, *H. cercidicolum*, *H. julianii* and *H. subticinense* all largely resembled *H. rubiginosum* with regard to their secondary metabolite profiles. While BNT (**5**) was absent, at least one compound of the mitorubrin (**1** - **3**) metabolite family and rubiginosin A (**4**) were always detected as major metabolites. Differences were noted with regard to their lipophilic constituents (i.e., metabolites eluting after mitorubrinol acetate). For instance, *H. julianii* and *H. rutilum* only contained an additional main metabolite **HR1** with Rt = 9.2 min, which was not present in any other species (Fig. 2). This metabolite could not be identified, due to the small quantities of stromatal materials available from these relatively rare species. Yet another, apparently specific metabolite was also found in the extract of *H. ferrugineum* as a co-metabolite of azaphilones. However, the occurrence of this compound should be verified by concurrent studies on type and further authentic material. Albeit we agree with Petrini & Müller (1986) that this specimen showed the typical characteristics of *H. ferrugineum*, it was reported from *Sorbus* rather than from *Tilia*, the usual host of this species (cf. Ju & Rogers 1996). In any case, its metabolite profile was different from that of *H. rubiginosum*. The amount of mitorubrin (**1**) was found particularly high in the freshly collected *H. cercidicolum*, as well as in *H. ferrugineum, H. julianii*, *H. laschii* and *H. rutilum*, while these species did not contain much or were even found devoid of the mitorubrin derivatives **2** and **3**. Therefore, it is possible that the latter fungi are not capable of converting mitorubrin into the hydroxylated derivative **2** and its acetate **3**. Likewise, the metabolite profiles of *H. ticinense* and *H. subticinense* differed in the presence of mitorubrinol acetate (**3**) only in the former and rubiginosin A (**4**) in the latter.

As reported previously, high contents of mitorubrinol are also typical of *H. subticinense* and both varieties of *H. subgilvum* (Hellwig et al. 2004). However, the significance of the latter results should be confirmed, based on a larger number of specimens, preferably of different developmental stages. The methodology employed is not quite suitable to establish a quantitative chemotaxonomy, anyway, because the amounts of materials extracted can hardly be standardised.

In any case, the employed HPLC profiling methodology proved perhaps even more valuable than in *Daldinia* (Stadler et al. 2001a,b) because of the apparent high diversity of specific compounds in *Hypoxylon* sect. *Hypoxylon*. Similar methodology could certainly find further application to solve some immanent taxonomic problems in *Xylariaceae* and other fungi, in conjunction with or as a prerequisite for morphological and molecular studies.

Table 1. Occurrence of characteristic stromatal metabolites in European species of *Hypoxylon* sect. *Hypoxylon* as deduced from HPLC profiling.

Species	**Secondary metabolites detected by HPLC analysis**							
	1	**2**	**3**	**4**	**5**	**6**	**9**	**Other or remarks**
H. cercidicolum (France)	++	(+)	—	+	—	(+)	+	unknown metabolites found in *H. suborbiculare* lacking
H. cercidicolum (NYS, *H. suborbiculare*, Type)	(+)	—	—	—	—	(+)	+	unknown metabolites prevailing, possibly artefacts or specific compounds
H. ferrugineum	++	+	(+)	—	—	+	—	characteristic peak at Rt = 7.4 min.
*H. fragiforme**	+	+	+	—	—	+	—	see Mühlbauer et al. (2002)
*H. fuscum**	—	—	—	—	+	—	—	Daldinins, see Quang et al. (2004b)
H. howeianum	+	+	+	—	—	+	—	see Mühlbauer et al. (2002)
H. intermedium	—	—	—	—	—	+	—	Hypomiltin (**7**) and congeners with similar UV
H. julianii	++	—	—	+	—	+	+	Peak **HR1** with Rt= 9.06 min
H. laschii	++	—	—	(+)	—	+	—	
*H. macrocarpum**	—	—	—	—	+	+	—	macrocarpones, see Mühlbauer et al. (2002)
H. petriniae	—	—	—	++	+	(+)	+	
H. perforatum	—	—	—	—	—	+	—	hypomiltin (**7**) and congeners with similar UV
H. rubiginosum	+	—	—	++	—	+	+	rubiginosin (**9**)
H. rutilum	++	—	—	+	—	+	—	Peak **HR1** with Rt= 9.06 min
H. subticinense	+	++	—	+	—	+	+	
H. ticinense	+/++	+/++	+	—	—	(+)	—	

A) SECONDARY METABOLITES**:** **1**= mitorubrin, **2** = mitorubrinol; **3** = mitorubrinol acetate; **4** = rubiginosin A; **5** = binaphthalenetetrol (BNT); **6** = orsellinic acid; **9** = rubiginosin C; chemical structures see Fig. 1; **HR1**, unknown compound; see Fig. 2.

B) INTENSITY OF PEAKS: **++** = main peak (over 50% of UV absorption of total components at 210 nm); **+** = major component (5-50% UV adsorption of total components at 210 nm); **(+)** = minor components (detected only by HPLC-MS and/or UV adsorption < 5% of total components in extract at 210 nm); **—** = neither detected by HPLC-UV nor by HPLC-MS.

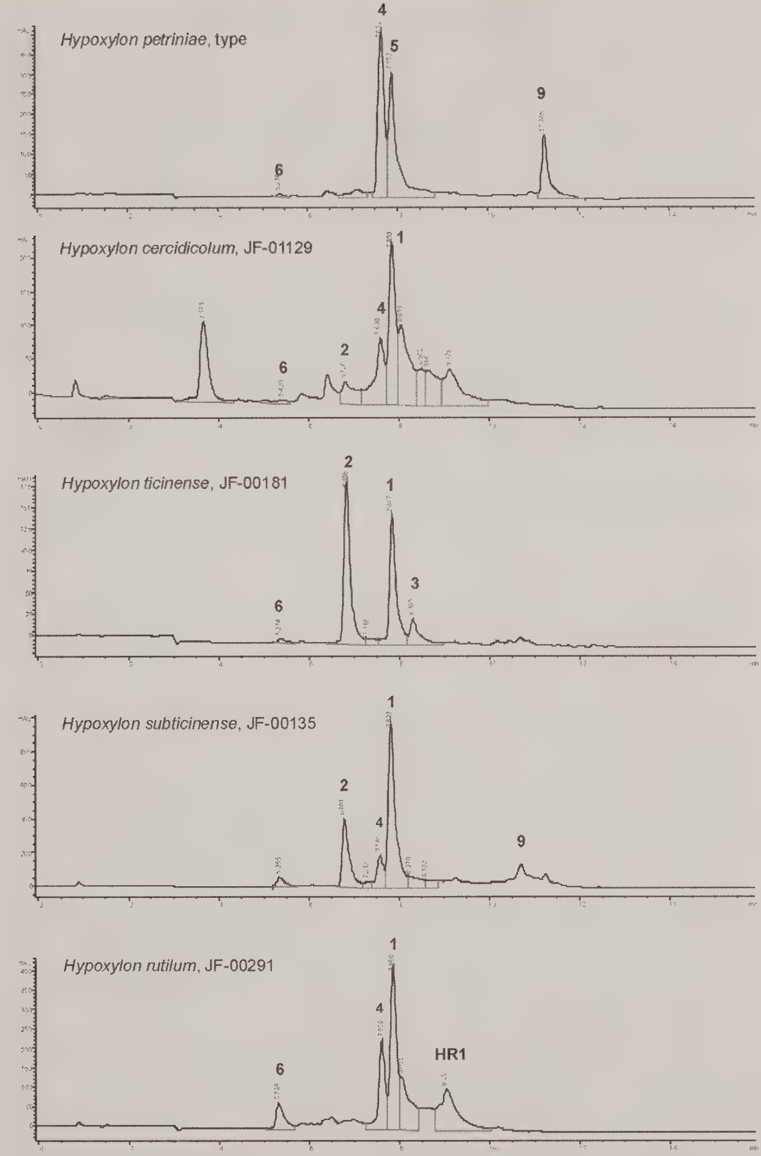


Fig. 2. HPLC-UV chromatograms (210 nm) of stromatal MeOH extracts of some *Hypoxylon* spp. For chemical structures of compounds **1** – **6** and **9** see Fig. 1 and for their HPLC characteristics Mühlbauer et al. (2002) and Quang et al. (2004b). **HR1** = unidentified compound.

B. Morphology and Taxonomy

Hypoxylon petriniae **M. Stadler & J. Fournier** ***sp. nov.*** **FIGURES 3a, 4-5,6a,7-8**

Stromata in ligno *Fraxini* vel (raro) *Populi* decorticato vel corticato, irregulariter effusa vel elongata, applanata, 6-60(-120) mm longa x 3-22(-25) mm lata x 0.3-0.8 mm crassa, margi stromatibus nigri et recti. Externe lilacea, rufobrunnea vel brunneo-vinacea, demum denigrata, superficie leviter rugosa, sine tumulis perithecorium, sub superficie granulis luteo-brunneis conspersa, granulis ferrugineis vel aurantiacis in KOH dissolutis; textura inter perithecia brunnea medullosa, textura sub peritheciis tenua, exigua. **Perithecia** sphaerica vel obovoidea, 0.25–0.5 mm alta x 0.25–0.38 mm diametro. **Ostiola** umbilicata. **Asci** 115-145 μm longitudine tota, 7-10 μm lati; partibus sporiferis 65-85 μm longi, stipitibus 37-64(-72) μm longi. Annulo apicali discoideo, 0.8-1 μm alto x 2.7-3.4 μm lato, in liquore iodato Melzeri cyanescente. **Ascosporae** brunneolae, unicellulares, ellipsoideo-inequilaterales vel leviter falcatae, apicibus angustatis, 8.8-11.5(-13) x 4.8-6 μm, rima germinativa recta, longa in latere convexo praeditae, perisporium in KOH dehiscens, leve, episporium leve.

Etymology: Named for the Swiss mycologist, Liliane E. Petrini.

= ***Hypoxylon cercidicola*** (Berk. & M. A. Curtis ex Peck) Y.-M. Ju & J. D. Rogers *sensu* A. Granmo, Sommerfeltia 26, 1999. p. 26-28 and Figs. 3A-C, 12, 36]; *non* Y.-M. Ju & J. D. Rogers, A Revision of the Genus *Hypoxylon*, p. 95. 1996.

= ***Hypoxylon rubiginosum*** (Pers.: Fr.) Fr. **var.** ***cercidicola*** (Berk. & M. A. Curtis ex Peck) L. E. Petrini *apud* L. E. Petrini & E. Müller, Mycol. Helv. 1: 533, 1986. p. 533-534 and Fig. 14].

Stromata (Fig. 3a) on decorticated wood or bark of *Fraxinus* (*excelsior*), or, rarely, *Populus*, elongate to irregularly effused, plane, with inconspicuous perithecial mounds, usually finely wrinkled, 6-60 (-120) mm long x 3-22 (-25) mm broad x 0.3-0.8 mm thick; margins black and linear, surface lilac (54), vinaceous (57) to brown vinaceous (84); yellowish brown, orange (7) to rust (39) granules beneath surface and between perithecia, with KOH-extractable pigments orange (7) or rust (39); the tissue below the perithecial layer inconspicuous, up to 0.4 mm thick, dark brown to blackish.

Perithecia spherical to obovoid, 250-380 μm diam x 250-500 μm high. **Ostioles** umbilicate, on mature stromata surrounded by a ring of white material 50-70 μm diam. **Asci** 115-145 μm total length x 7-10 μm broad, the spore bearing-parts 65-85 μm long, the stipes 37-64(-72) μm long, with apical ring amyloid, discoid, 0.8-1 μm high x 2.7-3.4 μm broad. **Ascospores** (Fig. 5) brown, ellipsoid-inequilateral to slightly falcate, 8.8-11.5(-13) x 4.8-6 μm, M (n=300) = 10.7 x 5.1 μm, with straight germ slit spore-length on the more convex side of the spore; perispore dehiscent in 10% KOH, appearing smooth by L.M., but showing conspicuous transverse striations by SEM (Fig. 6a).

Cultures and anamorph (Figs. 7-8): **Colonies** on 2% Difco Oatmeal agar at ca. 20 °C and under 12h of fluorescent light reaching the edge of a 9 cm Petri dish in 9-11 days, at first whitish, felty, zonate, with diffuse margins, becoming greyish brown when sporulating, reverse brown. Occasionally (see Fig. 7) infertile stromata are observed after 3-4 wk., but no teleomorph is produced. Sporulating regions appearing after 13-15 days of incubation, at first sparsely appearing on the margins of colony, later numerous and scattered over entire surface of colony, greyish brown. **Conidiogenous structure** *Virgariella*-like, conidiophores 80-170 x 2.5-3 μm, hyaline, smooth to finely roughened, containing one or two conidiogenous cells at each terminus. Conidia produced in basipetal sequence from sympodially proliferating conidiogenous cells, which are located exclusively at the apices of conidiophores, never intercalary. **Conidiogenous cells** hyaline, smooth, 25-50 x 2.5-3 µm. Conidia hyaline, smooth or finely roughened, ellipsoid, (6.5-)7-8 x 3-4 µm.

Anamorph on stromata at margins of young stromata or on old stromata, pale yellow to ochraceous, velvety. **Conidiogenous structure** *Virgariella*-like, mostly dichotomously branched, much like the anamorph in culture, conidiophores slightly roughened, up to 95 mm long x 3 µm broad, yellowish to light brown. **Conidiogenous cells** cylindrical, variable in size, 10-30(-35) x 2-3 µm. **Conidia** ellipsoid, (6-)7-8(-8.5) x 3-4 µm, hyaline or yellowish brown.

TYPUS: **FRANCE. Ariège:** RIMONT, Las Muros, *Fraxinus excelsior*, 18.V.2001, J. Fournier, *JF 01096* (**M**, HOLOTYPUS), culture CBS 114746.

FURTHER REPRESENTATIVE SPECIMENS EXAMINED (if not indicated otherwise, those were collected and identified by J. Fournier): FRANCE. Ariège: RIMONT, Las Muros, *Fraxinus excelsior*, associated with *H. rubiginosum*, 02.IX.2000, *JF-00180A*, CULTURED. – dto, *Fraxinus excelsior*, associated with *H. rubiginosum*, 15.VI.2003, *JF 03100A*, CULTURED. – dto, *Populus tremula*, associated with *Hypoxylon perforatum*, *H. rubiginosum* and *Eutypa sparsa*, 16.VIII.2003, *JF-03139A*#, CULTURED, CBS 115158. – dto., 01.X.2003, on bark of *Fraxinus excelsior*, JF-03187, CULTURED, CBS 115272. – RIMONT, Binette, *Fraxinus excelsior*, 26.IV.2000, *JF-00044*. – PRAT COMMUNAL, Loumet, decorticated wood of *Fraxinus excelsior*, 22.VIII.2003, *JF-03151*, CULTURED. – Isère: region of Lac de PALADRU, ca. 0.8 km SE of PALADRU, edge of Marais de la Véronnière, on decorticated fallen branch of *Fraxinus*, 29.VII.2003, D. Triebel & G. Rambold *G.R.-9574* (M), associated with *H. perforatum* and *H. rubiginosum*, CULTURED, CBS 115278. – dto., ca. 11 km NW of VOIRON, region of Lac de PALADRU, Bilieu, ca. 1 km SW of the church of Bilieu, rotten branch of cf. *Fraxinus*, 26.VIII.2003, D. Triebel & G. Rambold *G.R.-9578* (M), CULTURED, CBS 115279. – Morbihan: PLOHARS, Pont du Douar, Forêt de Carnoët, bark of *Fraxinus*, 26.X. 2002, P. Leroy, *JF-02204*, CULTURED. – Vendée: LA TRANCHE sur MER, La Savinière, *Fraxinus*, 02.VI.2003, *JF 030078*, CULTURED. – AVRILLE, Bois de la Garde, *Fraxinus*, 05.VI.2003, *JF-03091*, CULTURED.– GERMANY. North Rhine Westphalia: WUPPERTAL-APRATH, in mixed forest near hospital "Diakonie Aprath", corticated wood of *Fraxinus*, 28.IX.2003, *STMA 03073*. – dto., WUPPERTAL-LÜNTENBECK, corticated wood of *Fraxinus*, 29.XII.2003, *STMA 04W02*, CULTURED. – SWITZERLAND. Tessin: Morbio Superiore, Val della Credo, 04.IV.1983, L. & O. Petrini, as *H. rubiginosum* var. *cercidicola* (ZT) – UNITED KINGDOM. Wales: RUTHIAN, Llysfair Memorial Wood, *Fraxinus*, 07.II.1981, A.J.S. Whalley 771, det. L. Petrini as *H. rubiginosum* var. *cercidicola* (ZT).

COMMENTS: This species agrees well with previous descriptions of *H. rubiginosum* var. *cercidicola* (Petrini & Müller 1986) and *H. cercidicola* (Granmo 1999). This was even confirmed by authentic materials studied by the former authors collected from Switzerland and Wales, which were kindly provided by the curators of ZT. The anamorph is also in agreement with previous descriptions by Ju & Rogers (1996) and Greenhalgh & Chesters (1968) mentioned in the introduction. Based on these results, we agree with Granmo (1999) that this species is certainly not rare. It probably occurs throughout Europe in the distributional area of *Fraxinus*, and is most likely also present in America (cf. "Notes to *H. rubiginosum*" in Ju & Rogers 1996, for a Mexican *Hypoxylon* sp., sharing these characteristics).

The secondary metabolites of *H. rubiginosum* and ***H. petriniae*** in culture were also studied for comparison, using the method described by Stadler et al. (2001a). While mellein derivatives (Whalley & Edwards 1995) were prevailing in submerged YMG cultures for both species and all cultures examined in the current study, the ethyl acetate extract of a 5 weeks old Difco OA plate of ***H. petriniae*** JF-03091 contained BNT (**5**), which lacked in *H. rubiginosum* and was so far not found in *Xylariaceae* cultures (Stadler et al. 2001a). As *H. rubiginosum* cultures always produced dense yellow pigments in agar culture, it should be worthwhile to examine a larger number of taxa on secondary metabolites produced on Difco OA plates. The most striking differences between *H. petriniae* and *H. rubiginosum* are compiled in Table 2.

Table 2. Main diagnostic characters discriminating *Hypoxylon rubiginosum* from ***H. petriniae***

	H. petriniae	***H. rubiginosum***
Stromatal colour (Rayner 1970)	Lilac (54), vinaceous (57), brown vinaceous (84)	Rust (39), bay (6), sienna (8) dark brick (60)
Margin	Black, linear	Yellow to orange, effused
Perithecial mounds	Inconspicuous	More or less conspicuous, 2/3-1/2 immersed to almost naked
Basal tissue	Up to 0.4 mm thick	0.5-1.5 mm thick
Stromatal shape	Effused	Effused-pulvinate to pulvinate
Perithecia	Up to 500 μm high	Up to 800 μm high
Ascospore dimensions	M = 10.7 x 5.1 μm	M = 10.1 x 4.4 μm
Apical ring dimensions	0.8-1 x 2.7-3.4 μm	0.5-1.5 x 2-2.7 μm
Ascal width	7-10 μm	5.5-8 μm
Ascal stipes	37-64(-72) μm long	60-98 μm long
Anamorph	*Virgariella*-like branching pattern*	*Nodulisporium*-like branching pattern*
Conidiogenous cells	2 μm broad	2.5-3 μm broad
Conidia	5-7.5 x 3.5-4 μm	5-6 x 3-4 μm
Hosts	mostly *Fraxinus* (*excelsior*)	no apparent host specificity (also frequent on *Fraxinus*)
Secondary metabolites	BNT (tetrahydroxybinaththyl) present, mitorubrin absent	BNT absent, mitorubrin present

*as defined in Ju & Rogers (1996)

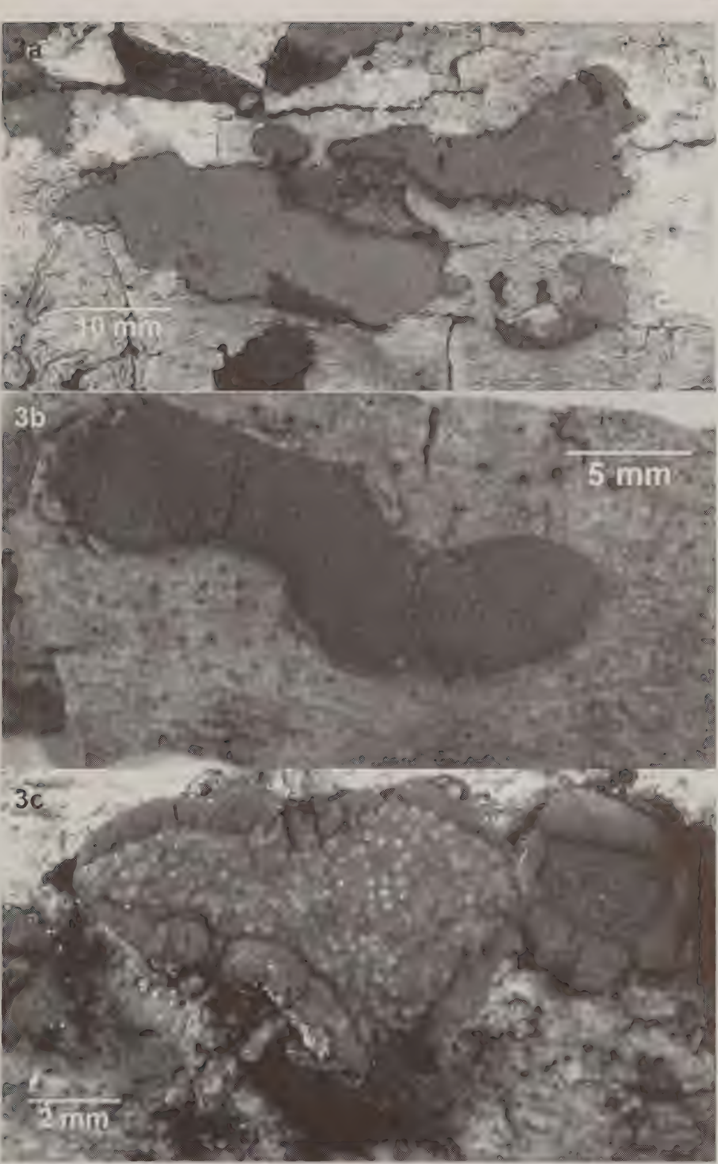
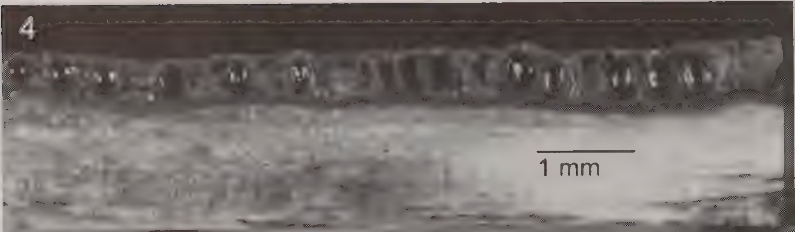
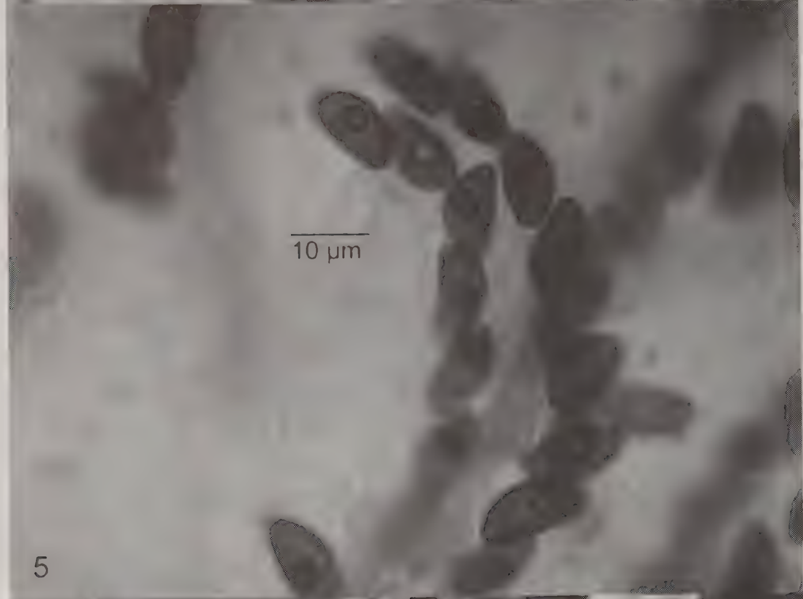


Fig. 3. Stromata of *Hypoxylon* spp. **Fig. 3a**. *H. petriniae* (HOLOTYPE-M). **Fig. 3b**. *H. suborbiculare* (TYPE-NYS). **Fig. 3c**. *H. cercidicolum*, JF-01129, showing a mature ascigenous stroma (left) as well as immature one (*Hadrotrichum* anamorph, right). Scale is indicated by bars.





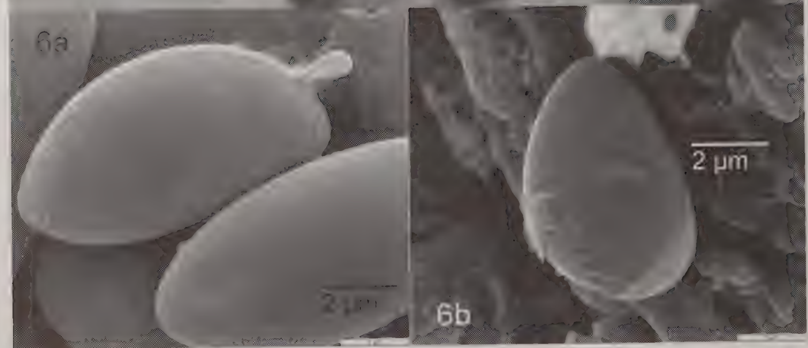
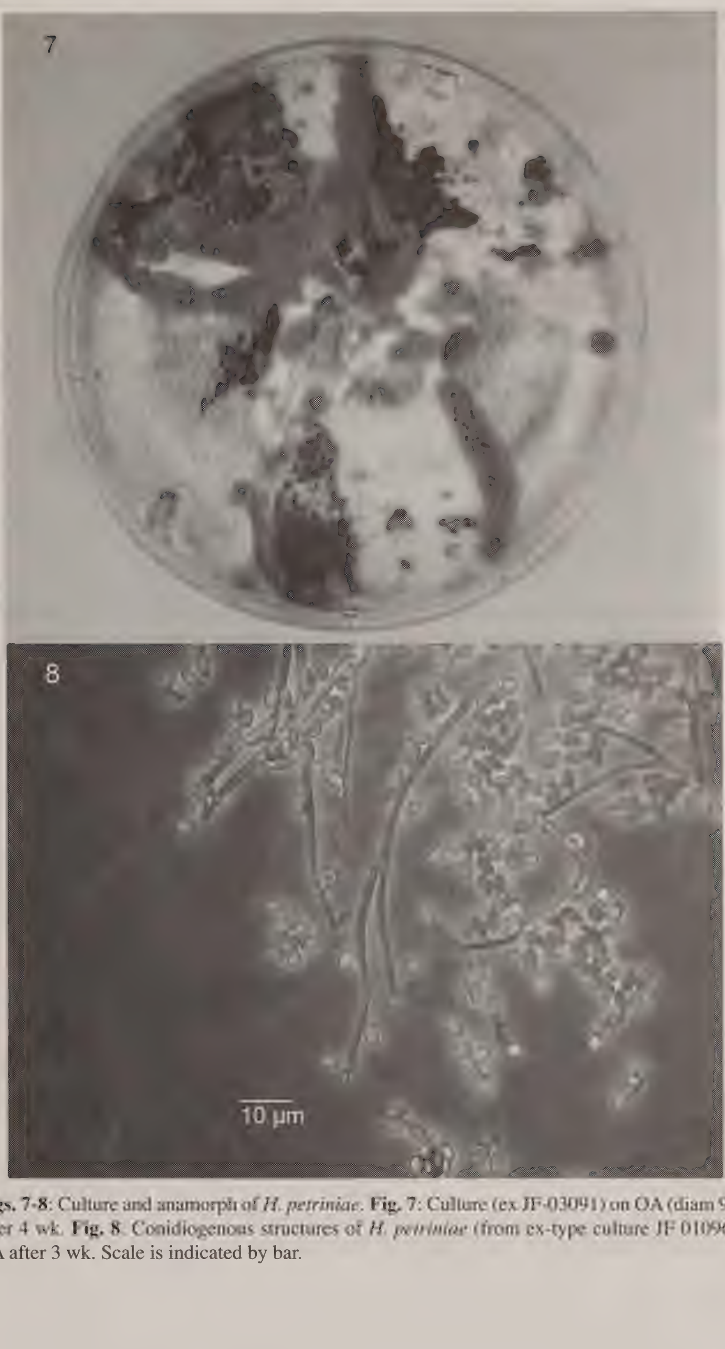


Fig. 4. *H. petriniae*, JF03187, perithecia; **Fig. 5**: *H. petriniae*, ascospores by L.M. (1000x). **Fig. 6.** SEM of ascospores of *Hypoxylon* spp. at 10,000x magnification **Fig. 6a**. *H. petriniae* (from type, M); **Fig. 6b**. *H. cercidicolum* (*H. suborbiculare*, from type, NYS). Scale is indicated by bars.



Figs. 7-8: Culture and anamorph of *H. petriniae*. **Fig. 7**: Culture (ex JF-03091) on OA (diam 9 cm) after 4 wk. **Fig. 8**. Conidiogenous structures of *H. petriniae* (from ex-type culture JF 01096) on OA after 3 wk. Scale is indicated by bar.

Characteristics of the type of *H. suborbiculare*

One task of the current study was exclusion of the conspecificity of *H. cercidicolum* ss. Ju & Rogers (1996) with ***H. petriniae***. The name *H. cercidicoum* goes back to *Diatrype cercidicola* Berk. & M. A. Curtis ex Peck. The etymology of this species is puzzling as it was never recorded from *Cercis* as would be indicated by its name, but the original substrate was identified as *Fraxinus nigra*, an American species of Ash. In the protologue of this fungus, Peck (1873) described a pyrenomycete "*with plane black stromata, 3-4 inches in diam, thin, seated on the inner bark, surrounded by the ruptured epidermis, dotted by the minute depressed or umbilicate at length perforate ostiola, perithecia crowded, elliptical or ovate, spores unequally ovate, colored, 0.004 inches long*". Peck himself subsequently named this fungus *H. suborbiculare* Peck (Peck 1879), creating a later synonym. Peck's type material of *H. suborbiculare* was kindly provided by NYS and studied concurrently. The stromata were much as described by Peck and only examined superficially to save the valuable material. As can be seen by comparison of Figs. 3a -c, their habit was somewhat different from the typical erumpent form of *H. cercidicolum*, which is usually encountered on *Fraxinus* in Europe. Certainly, they both differed from ***H. petriniae***.

In one piece of wood of the NYS specimen, a stroma whose morphological features and metabolite profiles were reminiscent of *H. rubiginosum* was observed. Hence, we suspect that the specimen may constitute a mixed collection comprising two *Hypoxylon* spp. In the remaining parts of the specimen, a homogenous morphology was observed: All stromata were plane, effused but the stromata appeared higher than in ***H. petriniae***, and they lacked the characteristic black margin of the new species. In attempts to observe ascal structures, some water mounts were prepared, but no asci, no apical ring, and only a few ascospores measuring 10-11 x 4-5 μm were seen in the probes. Some of those were prepared for SEM (Fig. 6b).

The HPLC data of this material were not quite conclusive as its extracts contained several peaks that were not observed in recently collected *Hypoxylon* spp. and might therefore constitute artefacts. Only traces of orsellinic acid (**6**) and mitorubrin (**1**) but neither rubiginosin A (**4**) nor BNT (**5**) were detected in the small portion of the material that was extracted for comparison. The metabolite profile differed from those of both *H. rubiginosum* and ***H. petriniae*** and rather appeared more reminiscent of *H. cercidicolum*. A comparison of ascospores of ***H. petriniae*** and the type of *H. suborbiculare* by SEM (Fig. 6) was made. Besides being larger in size, the spores of the new taxon also showed very conspicuous transverse striations on their outermost layer, while those of the type of *H. suborbiculare* appeared almost smooth when observed at the same magnification. These results pointed against the conspecificity between *D. cercidicola* and Petrini's interpretation on *H. rubiginosum* var. *cercidicola* (i.e., ***H. petriniae***) as suggested by Granmo (1999). The correspondence of *H. cercidicolum* with further synonyms proposed by Ju & Rogers (1996), however, remains to be evaluated by such methodology.

Notes on other *Hypoxylon* spp.

The current study confirmed the results of Ju & Rogers (1996), who found that *H. laschii* and *H. perforatum* are different taxa. Both had been segregated from *H. rubiginosum* ss. Miller (1961) as *H. rubiginosum* var. *perforatum* by Petrini & Müller (1986). Their materials came from various hosts, including *Populus*, *Fagus* and *Fraxinus*, while *H. laschii* shows apparent host specificity to *Populus*. *H. laschii* and *H. perforatum* also significantly differ in their secondary metabolite profiles, in agreement with their characteristic stromatal pigments in KOH.

While the morphology of cultures obtained from *H. perforatum* was in full agreement with previous descriptions by Petrini & Müller (1986) and Ju & Rogers (1996), our material of *H. laschii* unfortunately did not yield viable cultures, and studies on the anamorph of this species must therefore await collections of fresh specimens. *H. intermedium* [syn. *H. argillaceum* (Pers.) Nitschke and *H. fraxinophilum* Pouz. fide Ju & Rogers 1996] contained orsellinic acid and the novel azaphilone, hypomiltin. This species thus appears unrelated to the former taxa and further species of the "*H. rubiginosum* complex" as inferred from chemotaxonomic data. In contrast to Ju & Rogers (1996), who had not observed an anamorph in their cultures of *H. intermedium*, the culture of JF-03128 occasionally produced a *Sporothrix*-like anamorph when propagated on YMG agar, but not on OA.

The anamorphic structures were in agreement with those reported by Greenhalgh & Chesters (1968) for this species (as *H. argillaceum*). On OA, the morphology of this culture agreed with that reported for this species by Ju & Rogers (1996). The anamorph of *H. rutilum* was also found in agreement with the description in Ju & Rogers (1996) of a culture made from material of Taiwanese origin, further confirming that this species is present in Europe as well as in Asia.

An updated key to European species of *Hypoxylon*

We found it practical to provide a key to the species of *Hypoxylon* that have so far been encountered in Europe. If found appropriate, particular hosts, habitats and countries of origin will also be keyed out. If not indicated otherwise, ascospore sizes were given according to Ju & Rogers (1996), and detailed descriptions of the status of these taxa can also be found in the latter monograph. Otherwise, (e.g., if the species were described after 1996) the appropriate reference is cited. We also refer to a concurrent update of the monograph by Ju et al. (2004), containing additional information on the genus but not including any further descriptions of European *Hypoxylon* species.

Unlike those in Ju & Rogers (1996) and Ju et al. (2004), our key is not strictly divided into sect. *Annulata* and *Hypoxylon*, but all members of sect. *Annulata* are to be found in Part A and (**An**.) has been added after their Latin names. All taxa keyed out in part B, as well as the remaining species listed in Part A, however, belong to sect. *Hypoxylon*. Colours of stromatal pigments are occasionally deviating from the data given by Ju & Rogers (1996), presumably because more fresh specimens were included here, which tend to yield pigments that may be absent or slightly different in overmature and aged herbarium specimens. Some important parameters of the key are also based on the results of previous treatments of *Hypoxylon* by Petrini & Müller (1986) and Granmo (1999, 2001).

We hope that this key will contribute to an increase in our knowledge about the distribution of presumably rare taxa. Hence, special emphasis is given to characters that can be observed either in the field or upon examination of freshly collected specimens.

Ostioles papillate, opening higher than the stromatal surface *Key* **A**

Ostioles umbilicate or obsolete, opening lower than or at the same level as the stromatal surface *Key* **B**

Key A. Ostioles papillate

A- Ostioles encircled by a conspicuous flattened to slightly concave disc **A1**
A- Ostioles not encircled by a disc **A2**

A1(A)- Perithecial mounds inconspicuous; ascospores 6-8 x 3-3.5 µm, recorded from *Acer*, *Castanea*, *Carpinus* and *Quercus*, in France and Russia ***H. stygium*** (Lév.) Sacc. **var. *annulatum*** (Rehm) Y.-M. Ju & J. D. Rogers (An.)
A1- Perithecial mounds conspicuous; ascospores 11-15 x 4.5-5.5 µm, associated in Southern Europe (Italy, Portugal, Spain) with *Laurus* ***H. michelianum*** Ces. & De Not. (An.)

A2(A1)- Perithecia small, 0.2-0.3(-0.4) mm diam, the tissue below the perithecial layer weakly developed, <0.3 mm thick; stromata effused to pulvinate **A3**
A2- Perithecia larger, 0.4-0.6 mm diam, the tissue below the perithecial layer 0.5-3.5 mm thick; stromata pulvinate to peltate, often constricted at base, often coalescent **A7**

A3(A2)- Mature stromata waxy, with KOH-extractable pigments **A4**
A3- Mature stromata carbonaceous, black, without KOH-extractable pigments [but immature stromata orange, with dark livid (80) to dark vinaceous (82) pigments]. Ascospores 9.5-11.5 x 4-5.5 µm. USA, recently first recorded from France (current study). ***H. submonticulosum*** Y.-M. Ju & J. D. Rogers

A4(A3)- Stromata umber (9), rust (39) or sepia (63), with KOH-extractable pigments orange (7); ascospores averaging less than 20 µm long **A5**
A4- Stromatal surface with vinaceous (57) or purple (35) shades, with KOH-extractable pigments olivaceous (48), greenish olivaceous (90), vinaceous grey (116) or absent; ascospores averaging more than 20 µm long **A6**

A5(A4)- Ascospores averaging more than 15 µm long; 15-18 x 6-7.5 µm, without apparent host specificity ***H. julianii*** L. E. Petrini
A5- Ascospores averaging less than 11 µm long; 7.5-10 x 4-4.8 µm; distribution apparently world-wide, without apparent host specificity ***H. rutilum*** Tul. & C. Tul.

A6(A4)- KOH-extractable pigments greenish olivaceous (90) or with brown tones, ascospores 22-31 x 8.5-11 µm with faint germ slit less than spore-length; distribution boreal (Europe, North America), preferably in glaciated areas, mostly on *Salix*. ***H. macrosporum*** P. Karst.
A6- KOH-extractable pigments pale vinaceous grey (115) to vinaceous grey (116) in fresh specimens or absent in aged specimens, ascospores 18.5-23 x 8-10 µm with conspicuous germ slit spore-length. Frequently on *Ulmus* (France) but also on other hosts ***H. vogesiacum*** (Pers.) Sacc.

A7(A2)- KOH-extractable pigments orange (7) to rust (39); stromata pulvinate, erumpent, apparently restricted to *Populus*, ascospores 8-10 x 3.5-4.5 µm. Recorded from Germany (type locality), Finland, France and USA (Ju & Rogers 1996) ***H. laschii*** Nitschke
A7- KOH-extractable pigments different **A8**

A8 (A7)- Ascospores 6.5-8.5 x 3-4 µm; on *Quercus*, *Castanea,* and *Erica arborea* in western Europe ***H. cohaerens*** (Pers. : Fr.) Fr. var. ***microsporum*** J. D. Rogers & Cand. (An.)
A8- Ascospores larger; on different hosts **A9**

A9(A8)- Apparently restricted to *Fagus*, widespread; ascospores 9-11 x 4-5 µmwith germ slit spore-length ***H. cohaerens*** (Pers. : Fr.) Fr. (An.)
A9- Mainly associated with *Alnus, Betula* and *Corylus*, widespread; ascospores 8.5-12 x 3.5-5 µm with germ slit less than spore-length ***H. multiforme*** (Fr. : Fr.) Fr. (An.)

Key B: Ostioles not papillate

B- Stromata hemispherical to almost spherical **B1**
B- Stromata effused to pulvinate **B4**

B1(B)- Stromatal surface vinaceous grey (116), sepia (63) or grayish sepia (106), KOH-extractable pigments pure yellow (14), greenish yellow (16) or citrine (13), ascospores 17-22 x 9-11 μm; restricted to *Fraxinus* ***H. intermedium*** (Schwein.: Fr.) Y.-M. Ju & J. D. Rogers

B1- Stromatal surface rust (39), bay (6), or dark brick (60), KOH-extractable pigments orange (7), ascospores averaging less than 15 μm long **B2**

B2(B1)- Ascal apical ring present, amyloid **B3**
B2- Ascal apical ring absent, monotypic, not recorded since 1867, ascospores 9-11 x 4.5-5.5 μm ***H. commutatum*** Nitschke

B3(B2)- Widespread, mainly on *Fagus*; ascospores 11-13.5 x 5-6.5 μm ***H. fragiforme*** (Pers. : Fr.) J. Kickx fil.
B3- Widespread, on other hosts, rarely on *Fagus*; ascospores 7-9 x 3.5-5 μm ***H. howeianum*** Peck

B4(B)- Stromatal surface with purple (35) or vinaceous (57) colours **B5**
B4- Stromatal surface with orange (7), rust (39), brick (60), or brown colours **B12**

B5(B4)- Ascospores averaging more than 20 μm long **B6**
B5- Ascospores averaging less than 15 μm long **B7**

B6(B5)- KOH-extractable pigments pale vinaceous grey (115) to vinaceous grey (116) in fresh specimens or absent in aged specimens; ascospores 18.5-23 x 8-10 μm with germ slit spore-length (see also **A6**) ***H. vogesiacum*** (Pers.) Sacc.
B6- Boreal distribution, frequently on Salix, KOH-extractable pigments dense, greenish olivaceous (90); ascospores 22-31 x 8.5-11μm with faint germ slit less than spore-length (see also **A6**) ***H. macrosporum*** P. Karst.

B7(B5)- KOH-extractable pigments dilute, livid purple (81) or absent in aged specimens; ascospores 8-11.5 x 4.5-5 μm. Distribution world-wide, recently first recorded from Europe (France, current study) ***H. carneum*** Petch
B7- KOH-extractable pigments orange (7); ascospores 9-13 x 4-5.5 μm, newly erected herein ***H. petriniae*** M. Stadler & J. Fournier
B7- KOH-extractable pigments amber (47), isabelline (65), olivaceous (48), gray olivaceous (107), greenish olivaceous (90), citrine (13) or otherwise with yellow, green or brown tones **B8**

B8(B7)- Perithecia obovoid to frequently tubular, up to 1 mm high; stromatal surface with a metallic shine when mature. Recorded from Central and Western Europe and North America (various hosts). Ascospores 9.5-11.5 x 4-4.8 μm ***H. macrocarpum*** Pouz.
B8- Perithecia spherical to obovoid, not tubular; stromatal surface lacking a metallic shine when mature **B9**

B9(B8)- Ascospores with straight germ slit; ascal stipes shorter than the spore-bearing parts **B10**
B9- Ascospores with slightly sigmoid germ slit; ascal stipes as long as or longer than the spore-bearing parts **B11**

B10(B9)- Ascospores ellipsoid-inequilateral in lateral view, 9-12 x 4-6 μm, perispore dehiscent in 10% KOH. KOH-extractable pigments amber (47), greenish yellow (16) or citrine (13) ***H. perforatum*** (Schwein. : Fr.) Fr.

B10- Ascospores ellipsoid, nearly equilateral in lateral view, often pyriform, 12-15 x 5.5-7 μm, perispore indehiscent in 10% KOH. KOH-extractable pigments olivaceous (48), greenish olivaceous (90), gray olivaceous (127), or olivaceous gray (121). Apparently rare, so far known from USA, Germany and Austria (Mühlbauer et al. 2002). ***H. fuscopurpureum*** (Schwein.: Fr.) M. A. Curtis

B11(B9)- Stromata with pure yellow (14) to luteous (12) granules and greenish olivaceous (90) KOH-extractable pigments; apparently restricted to *Quercus*, with a boreal distribution; ascospores 10-13.5 x 4-5 μm. So far known from France (current study) and Scandinavia (Granmo 1999) ***H. porphyreum*** Granmo

B11- Stromata with sienna (8) or otherwise orange brown granules and KOH-extractable pigments amber (47), isabelline (65), olivaceous (48), gray olivaceous (107), or greenish olivaceous (90); widespread, on Betulaceae and other hosts, but not yet safely recorded from *Quercus*; ascospores 11-16 x 5-8 μm ***H. fuscum*** (Pers. : Fr.) Fr.

B12(B4)- Young stromata with a bright yellow to orange fimbriate margin; perithecia small, 0.1-0.3 mm diam, seated on a well developed black basal tissue **B13**

B12- Young stromata lacking a bright yellow to orange fimbriate margin **B14**

B13(B12)- Ascospores 5-7 x 2.5-3.5 μm, ellipsoid-inequilateral in lateral view. So far recorded from Austria, Croatia, France, Italy, Slovakia and Switzerland (Ripková & Hagara 2003) ***H. ticinense*** L. E. Petrini

B13- Ascospores 8-11 x 4-5 μm, ellipsoid-equilateral in lateral view. So far recorded from France and USA ***H. subticinense*** Y.-M. Ju & J. D. Rogers

B14(B12)- KOH-extractable pigments orange (7) **B15**

B14- KOH-extractable pigments with shades of olivaceous brown **B22**

B15(B14)- Ascal apical ring highly reduced or lacking, inamyloid **B16**

B15- Ascal apical ring present, amyloid **B17**

B16(B15)- Stromata applanate, discoid, encircled with a swollen stellate margin, on bark of *Fraxinus*; ascospores 9.5-12 x 5-6 μm. Central and Southern Europe (Pouzar 1972, Petrini & Müller 1986, as *H. moravicum* Pouz.) and North America (Canada, USA) fide Ju & Rogers (1996). ***H. cercidicolum*** (Berk. & M. A. Curtis ex Peck) Y.-M. Ju & J. D. Rogers

B16- Stromata pulvinate to hemispherical, ascospores 9-11 x 4.5-5.5 μm (rare, see also **B2**) ***H. commutatum*** Nitschke

B17(B16)- Ascospores averaging more than 14 μm long **B18**

B17- Ascospores averaging less than 12 μm long **B19**

B18(B17)- Stromata pulvinate restricted at base, with rust brown to ochraceous brown granules beneath surface; apparently rare, known only from *Tilia* and *Sorbus*; ascospores 14-17 x 6.5-8 μm, Recorded from Europe in Switzerland (Petrini & Müller 1986) and Slovakia (Z. Pouzar, unpublished) ***H. ferrugineum*** Otth

B18- Stromata effused to pulvinate, with red granules beneath surface, recorded from various hosts; ascospores 15-18 x 6-7.5 μm (see also A5) ***H. julianii*** L. E. Petrini

B19(B17)- Perithecia 0.1-0.35 mm diam; recorded from *Salix* in Northern Europe (Granmo 1999), and USA (Ju & Rogers, 1996); ascospores 7-10 x 3-4.5 μm ***H. salicicola*** Granmo
B19- Perithecia averaging more than 0.4 mm diam **B20**

B20(B19)- Stromata erumpent, pulvinate, small, up to 6 mm diam; on *Populus*; ascospores 8-10 x 3.5-4.5 μm (see also A7) ***H. laschii*** Nitschke
B20- Stromata non-erumpent, effused to pulvinate, larger **B21**

B21 (B20)- Stromatal surface rust (39) to brick (60), with dull orange granules beneath surface and between perithecia; KOH-extractable pigments orange (7). Widespread, without apparent host-specificity; ascospores brown, 9-13 x 4-5.5 μm ***H. rubiginosum*** (Pers. : Fr.) Fr.
B21- Stromatal surface vinaceous buff (86), greyish sepia (106) to brown vinaceous (84)with bright yellow granules beneath surface and between perithecia; KOH-extractable pigments hazel (88), sienna (8) to umber (9). Apparently restricted to *Sorbus*, with a boreal distribution; ascospores dark brown, 9.5-12.5 x 4.8-6 μm (Granmo 2001) ***H. liviae*** Granmo

B22 (20)- Ascospores dark brown, ellipsoid nearly equilateral. Apparently restricted to *Sorbus*; ascospores 9.5-12.5 x 4.8-6 μm (Granmo 2001, see also **B21**) ***H. liviae*** Granmo
B22- Ascospores medium brown, ellipsoid-inequilateral; without apparent host-specificity **B23**

B23(B22)- KOH-extractable pigments amber (47), greenish yellow (16) or citrine (13); ostioles surrounded by a conspicuous white material on mature stromata; perithecia spherical to obovoid, up to 0.4 mm high (see also **B10**) ***H. perforatum*** (Schwein. : Fr.) Fr.
B23- KOH-extractable pigments isabelline (65), umber (9), or grayish sepia (106); ostioles lacking white material; perithecia frequently tubular, up to 1 mm high (see also **B8**)
H. macrocarpum Pouz.

Acknowledgments

The authors are deeply indebted to Prof. Dr. Egon Horak and Ms. Annemarie Tanner (Mycological herbarium of ETH Zurich, Switzerland; **ZT**), Dr. Alfred Granmo (Univ. Tromsø, Norway) Dr. John Haines (Mycological herbarium of New York State Museum, **NYS**), and Dr. Dagmar Triebel (Botanische Staatsammlung, Munich, Germany, **M**), for providing valuable reference materials. They are especially grateful to Prof. Dr. Jack D. Rogers (Washington State Univ., Pullman, USA) and Dr. Yu-Ming Ju (Institute of Botany, Academia Sinica, Taipei, Taiwan), who provided further reference materials of American, Asian and tropical *Hypoxylon* spp., confirmed some of the determinations, critically reviewed the manuscript and came up with very important suggestions for improvements. Prof. Dr. Anthony J. S. Whalley (Liverpool John Moores University) and Dr. Zdeněk Pouzar (National Museum, Praha, Czech Republic) are also thanked for their critical reviews of subfinal versions of the manuscript and for valuable comments. Prof. Dr. Yoshinori Asakawa and Drs. Toshihiro Hashimoto and Dang Ngoc Quang (Tokushima Bunri University, Tokushima, Japan) and Dr. Veronika Hellwig (Bayer, Wuppertal) are thanked for structure determination of hypomiltin, rubiginosins, and further metabolites, and Dr. Stephan Seip (Bayer) for recording HPLC-MS. Expert technical assistance by Ms. Petra Splittgerber, Ms. Claudia Wotsch, Mr. Mario Göddertz and Mr. Dirk Müller (Bayer) is gratefully acknowledged.

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MYCOTAXON

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Tuber zhongdianense sp. nov. from China

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Abstract — A new truffle species is described and illustrated from Zhongdian (Shangri-La), Yunnan province in SW China. This new species is apparently mycorrhizal with *Quercus pannosa*. The relationship of the new species to other closely related species is discussed.

Key words — Ascomycota, *Pezizales*, taxonomy

In October, 2002, the authors visited Zhongdian County, Diqing Tibetan Autonomous Prefecture, Yunnan province, SW China, where three large rivers that run parallel from north to south cut through the southeast rim of the Tibet plateau. Very deep, narrow valleys and magnificent snowy mountains create distinctive vertical climate and vegetation patterns from the tropical valley floors to the glacial mountaintops. Unique plants and wildlife, such as the endemic Yunnan snub-nosed monkey, have been found there. Although *T. indicum* Cooke & Massee, *T. himalayense* B.C. Zhang & Minter, *T. sinense* K. Tao & Liu, *T. gigantosporum* Wang & Z.P Li, *T. pseudoexcavatum* Y. Wang, G. Moreno, Riousset, Manjón & G. Riosset, *T. huidongense* Y. Wang, *T. liui* A.S. Xu, and *T. xizangense* A.S. Xu have been recorded from neighboring areas (Wang & Li 1991; Wang et al. 1998; Wang & Hall 1999; Wang & He 2002; Xu 1999), no *Tuber* species have previously been reported from the Zhongdian region. We describe here both a new species and the first *Tuber* from the region.

Tuber zhongdianense sp. nov. **FIGURES 1-6**

Ascocarpa irregularis, usque ad 15 mm in diam, pallide brunnea, puberula. Peridium bistratum 220 µm crassum, straits doubus: epicutis 60-70 µm crassum, pseudoparenchymatis, subcutis 150-160 µm crassum, prosenchymatis. Pili densi,

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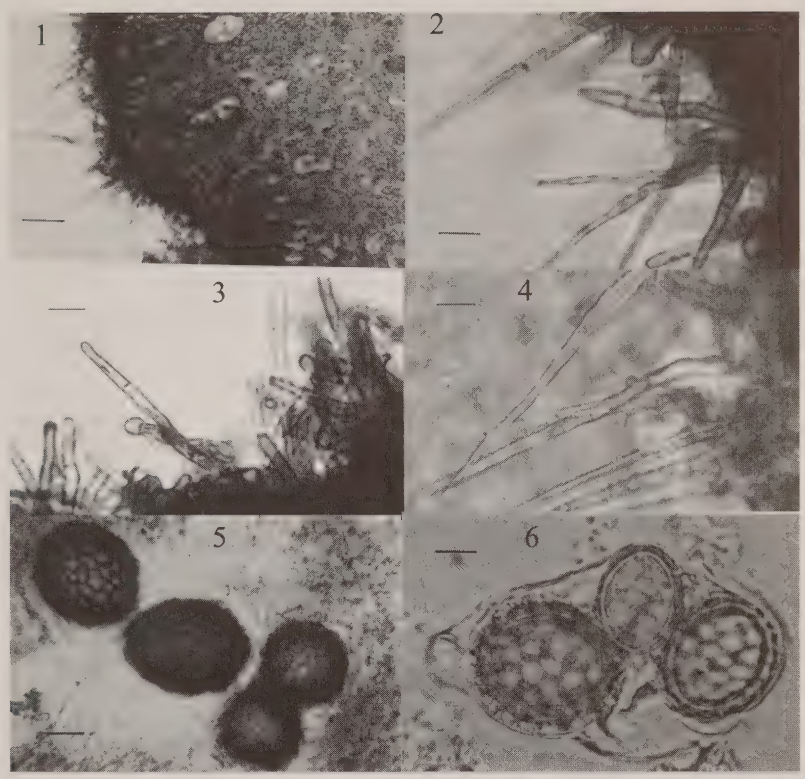
*Corresponding author

> *usque ad 95 µm longae, 4-5 µm crassae, unicellularae vel multicellularae. Gleba solida, brunnea, venis albis. Asci sporis 1-2, subglobosae vel irregularae, usque ad 109 x 73 µm. Ascosporae late ellipsoideae, 50-63 x 38-44 µm (ubi 1 spora in quaque asco), 33-44 x 29-38 µm (2-sporae), reticulatae. Habitat in ad terrata sub* Quercus pannosa, *alt. 3000m. Yunnan: Zhongdian.*
>
> ***Etymology:*** zhongdianense derives from Zhongdian, type locality for the fungus species.

Ascomata irregular and slightly lobed, pale brown, up to 15 mm in diam, puberulent, solid. **Odour** slight. **Peridium** 220 µm thick, composed of two layers; the outer layer complex, 60-70 µm thick, pseudoparenchymatous, composed of vertically arranged globose to rectangular cells, 19-32 x 13-15 µm and thin-walled; scattered large inflated hyaline cells, reaching 50 x 34 µm; the 2-µm thick walls giving rise at the surface to hairs in two layers; one type tall, tapered, reaching 95 x 4-5 µm, 2-3 septate and sometimes with a small teat on the wall, hyaline or yellowish, slightly thick-walled; other hairs short, obtuse, 0-1-2 septate, cylindrical (52 x 4 µm), flask-shaped (10 x 6 µm), obpyriform (19 x 8 µm) or spathulate (16 x 5 µm); the inner layer 150-160 µm thick, composed of 2-4 µm diam, interwoven, colourless hyphae that gradually merge into the gleba tissue. **Gleba** initially whitish, maturing to brown; veins distinct, white, branching and derived from many points on the periphery, some not entirely closed; inter-ascal hyphae colourless, interwoven, thin-walled, sometimes with thin-walled inflated cells, 18 x12 µm. **Asci** 1-2- (rarely 3-4-) spored, reaching 109 x 73 µm overall, walls 2-3 µm thick, colourless, broadly ellipsoid or obovoid (immature asci), oval to oblong (2-spored), pyriform (3-spored), or irregular (4-spored). **Ascospores** broadly ellipsoid, sizes excluding ornamentation 50-63 x 38-44 µm (1-spored asci), 33-44 x 29-38 µm (2-spored asci), or 27-37 x 23-33 µm (3-4-spored asci); walls 2-4 µm thick, brown (brownish yellow when young); reticulate with regular mesh, normally 7-11 meshes long, 6-9 meshes wide [from 5-6 meshes long and 6-7 meshes wide on smaller to 15-16 meshes long and 11-12 meshes long on larger spores], average ornamentation 2 µm high, occasionally to 6-7 µm tall.

> **Holotype here designated:** Zhongdian County (Shangri-La), Diqing Tibetan Autonomous Prefecture, Yunnan province, SW China, alt. 3000 m, under *Quercus pannosa* Hand-Mazz., 15 October 2002, Y. Wang 0299 (IFS).

This species is closely related to other European white truffle species with pseudoparenchymatous peridia with abundant surface hairs, such as *T. borchii* Vittad. *T. rapaeodorum* Tul. and *T. puberulum* Berk. & Broome (Mello et al. 2000; Trappe & Cázares 2000; Astier 1998; Pegler et al. 1993).



Figs. 1-6. Fig. 1. *Tuber zhongdianense* (Wang 0299): Section of peridium showing the two layers and big inflated cells (bar = 20 μm). **Fig. 2.** *Tuber zhongdianense* (Wang 0299): Surface hairs showing the two kinds of hairs (bar = 15 μm). **Fig. 3.** *Tuber zhongdianense* (Wang 0299): Long tapered surface hairs (bar = 10 μm). **Fig. 4.** *Tuber zhongdianense* (Wang 0299): Short obtuse surface hairs (bar = 13 μm). **Fig. 5.** *Tuber zhongdianense* (Wang 0299): Ascospores (bar = 20 μm). **Fig. 6.** *Tuber zhongdianense* (Wang 0299): Ascus and ascospores (bar = 10 μm).

T. zhongdianense differs in having two kinds of hairs – tapered and obtuse (Figs. 2, 3, 4) – and larger ascospores (Figs. 5, 6). This species differs from the similar *T. liui* from Tibet (Xu 1999) in its smaller ascospores with lower ornamentations (Figs. 5, 6). *T. zhongdianense* is also notable for having a pseudoparenchymatous epicutis composed of vertically arranged globose to rectangular cells (Fig. 1). The fact that the ascospores closely resemble those of

T. gigantosporum from the neighboring Sichuan province, also characterized by having very low (2-4 μm tall) ornamentation (Wang & Li 1991), suggests that they may be closely related phylogenetically.

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We are grateful to Dr Lorelei Norvell and Dr Michael Castellano for their very helpful comments on the manuscript. The help of Diqing Tibetan Autonomous Prefecture Forestry Bureau, Chuxiong Forestry Research Institute and Mr. Z.M. Tang in organizing this visit is also gratefully acknowledged. The senior author thanks the Institute of Applied Ecology, Academia Sinica, for financial support of this study.

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Book reviews and notices

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General

Biodiversity of Fungi: Inventory and monitoring methods. Edited by Gregory M. Mueller, Gerald F. Bills & Mercedes S. Foster. June 2004. Elsevier Academic Press, 200 Wheeler Road, Burlington, MA 01893, USA. Pp. xviii + 777. ISBN 0 12 509551 1. Price US $ 95.

Biodiversity of Fungi is an invaluable book for mycologists that are interested in ecology, taxonomy and conservation. The editors have brought together a series of chapters that describe sampling strategies and ecological principles based on phytosociological and survey practices that are more commonplace in ecology than they are in mycology. These organized and statistically robust survey methods are essential for mycologists to generate high quality quantitative and qualitative data on which to adequately assess the biodiversity and geographic distribution of fungi. Plant and animal ecologists have been doing this type of survey work for years, but mycological foray records have rarely had consistent methodologies. This book is suggesting the way forward and it is my hope that mycologists accept the principles of disciplined foray design strategies, rigorous database construction, and the maintenance of adequate herbarium collections. These thoughts are expanded upon in the introduction by the editors, which sets the scene for the following chapters.

The rest of the book is divided into three parts. Part I consists of six chapters that provide an overview of the methodologies required to adequately evaluate fungal diversity and maintain databases and herbaria. These chapters provide an overview of the fungal kingdom, showing how molecular tools have recently allowed us to reevaluate fungal taxonomy and evolutionary linkages between the ‘crown fungi’. We are told that herbaria have been around for over 200 years, but the key elements to compiling, maintaining and disseminating information from a good fungal herbarium is presented to us in detail to remind us of what we should be doing. This advice includes methods of isolation, culture, storage, database development (including examples of record sheet templates), the shipment of fungi around the world (based primarily on USDA APHIS regulations) with a near 'cook book' approach, which reinforces the idea that quality control should be strictly maintained between and within collection forays. John C. Zak and Michael R. Willig's chapter on biodiversity patterns reinforces the statistical issues in any ecological survey work. This chapter does an excellent job of introducing collecting effort functions, explaining richness and diversity measures and introduces the reader to multivariate statistical methods that not only allow us to obtain a good picture of how to identify changes in fungal community structure, but also allows us to relate these changes to environmental variables in a rigorous statistical way. This part of the book concludes with a chapter on molecular methods that assist in verifying morphological identifications of fungi, giving step-by-step procedures of PCR methods and their derivatives.

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Part II A of the book consists of four chapters that detail protocols that could or should be adopted to collect, isolate and study fungi from living plants, organic components of soil and wood, those that form lichens, and sequestrate fungi. Each chapter is a mini-treatise discussing some of the biology of the fungal groups that are found associated with these substratum types, followed by methods used to obtain samples and then how to culture the fungal species supported by the substrates. Each of these chapters is well-illustrated with line drawings, monochrome, and colour illustrations, that add value to the text and are just a pleasure to look at. The detail in each chapter varies, partly reflecting the extent of knowledge of each group of fungi or the ecology of that particular substrate. Most chapters discuss basic statistical problems of determining species-effort relationships and design of sampling strategies. An excellent example of this is a series of figures in Chapter 8 showing how different strategies for sampling macrofungi could be determined from preliminary surveys using adaptive cluster sampling. Although mentioned in some chapters, the problem of scaling is given little discussion. If we are to attempt to evaluate the global diversity of fungi we need to be able to make some attempt to statistically address our scaling of discovered diversity at the micro-, local, or landscape level to the regional and global level. This is not a trivial task and some pointers, as in the chapter on lichen-forming fungi, or open admissions of not knowing how to proceed would have been welcomed in the discussions in these chapters, especially as we learn that a 100 000 ha plot of tropical Costa Rican forest vegetation can yield 81 500 plant pathogenic fungi alone.

Part II B consists of seven chapters on the protocols for isolating particular functional groups of microfungi. These include microfungi of wood and plant debris, endophytes, saprotrophic soil fungi, fungi from stressful environments, arbuscular mycorrhizal fungi, yeasts, and fungicolous fungi. Each chapter follows the established format of a discussion of the biology of the fungi, a survey of the fungal species known to be associated with the substrate or environmental condition, and a discussion of the methods adopted to enumerate, identify, culture and store samples of each fungal group. Again, the chapters are richly illustrated with flow diagrams of procedures and photographs of apparatus or specimens.

Part II C discusses the associations of fungi with animals with five chapters looking at the diversity of fungi on insects and other arthropods, nematodes and rotifers, vertebrates, animal faeces, and a surprising chapter on the fungi involved with vertebrate guts and fibre degradation in anaerobic ecosystems. The discussion of arthropod fungal associates goes beyond the pathogenic forms and addresses fungi that are carried by insects and which act as plant pathogens. Gardens of fungi associated with ants and termites are also discussed. In both chapters discussing fungi of invertebrates, the authors address the problems with and methods for obtaining the fungal host animal. Methodologically this doubles the problems involved with sampling as the researcher needs to address statistical concerns of representatively capturing both the animal host and then the fungi that are associated with them.

The final section of Part II (D) takes four chapters to discuss fungi from aquatic habitats, considering freshwater and marine ecosystems, mycetozoans as a special group, and fungi associated with aquatic animals. One surprise was the lack of discussion of fungal pathogens of anurans. Pathogens of fish, crustaceans and molluscs are discussed and, given the recent interest in decline of tropical frog populations linked to fungal pathogens (Lipps 1999; Reed *et al.* 2000), this seemed to be a slight omission from this chapter!

The final section of the book consists of four very useful appendices. The first describes the manufacture and use of moist chambers for the culturing and isolation of fungi; an important technique that is frequently mentioned throughout the book. The second is an annotated recipe book of culture, antibiotic, fixative, staining, mounting and storage media that are used for fungi. The annotations describe their best use for different groups of fungi or different situations. A list of major fungal collections, databases and web sites assures us that there is the potential for cross referencing of material and extant discussions between countries throughout the world on the current knowledge of the diversity of fungi. The fourth appendix gives contact information of vendors of all things associated with mycology, herbarium management and software houses for database management.

The book finishes with a glossary compiled by Frank M. Dugan, which contains many simplistic, but graphic sketches that will be a great asset to those of us who attempt to teach mycology and 89 pages of literature cited. I mention the latter as this represents some 4000 citations to the mycological literature. This vast set of information ensures that any reader of this book will be capable of following-up and digging deeper into specific areas that appeal. This list of references alone makes the book worth while having on my bookshelf.

In the conclusion to their chapter on fungi from stressful environments, John C. Zak and Howard G. Wildman state that it had been difficult to compile standardized sampling strategies or isolation methods due to the varied habitats and life cycles of fungi. They suggest that the parallel use of multiple isolation techniques is the only way to adequately address the heterogeneity of resources in the world, which will yield complete assessments of fungal biodiversity patterns. Only then, they say, can we begin to understand the link between fungal community diversity and ecosystem function. This book is a splendid example of how we may take those steps by seeing the range of methods (procedural, statistical and educational) than need to be compiled to address attempts to understand the fungal community of any given habitat or geographical region. This is a resource book that will be used extensively during the forthcoming years as we attempt to tackle the task of unraveling the complexity of fungal communities and diversity.

This is an excellent book which has appeared at a time when biodiversity discussions are in the forefront of ecologists as a whole. If we are to progress further with understanding the development and function of communities of fungi and, especially if we are to attempt to relate the current knowledge of fungal diversity to fungal and ecosystem functioning, we need to have much more robust data on the actual diversity of fungi at all scales of resolution and improve out knowledge of their functional attributes. This book not only shows us the way to go, but tells us how to do so in a way that will maximize the quality of the data generated. The editors and chapter authors are to be congratulated on producing such a colourful and informative text.

Lips, K. R. (1999) Mass mortality and population declines of anurans at an upland site in western Panama. *Consrvation Biology* **13**: 117-125.

Reed, K. D., Ruth, G. R., Meyer, J. A. & Shukla, S. K. (2000) *Chlamydiapneumoniae* infection in a breeding colony of African clawed frogs (*Xenopus tropicalis*). *Emerging Infectious Diseases* **6**: 196-199.

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Fungi Fimicoli Italici: A guide to the recognition of basidiomycetes and ascomycetes living on faecal material. By Franceso Doveri. May 2004. Associazione Micologica Bresadola, Via A. Volta 46, I-38100 Trento, Italy. Pp. 1104, colour photographs 158, figures *ca* 300. ISBN not indicated. Price: € 110.

This is a remarkable work which will be sought-after by all field mycologists involved in inventory work. I only wish it had been available when I was endeavouring to record dung fungi in the Slapton Ley National Nature Reserve in Devon, south-west England, in the 1970s-80s. This is not the first work to provide keys and(or) descriptions of a wide range of dung fungi (e.g. Bell 1983, Richardson & Watling 1997, Ellis & Ellis 1998), but it is by far the most lavishly illustrated and comprehensive yet to appear on the market.

Here there are detailed accounts and keys or tabulations to over 300 species of basidio- and ascomycetes, but not of their anamorphs, other conidial fungi, mucoralean fungi, nor slime moulds. The individual species entries have full bibliographic information on both accepted names and synonyms, a copy of the original diagnosis (a most welcome feature), and list of collections examined. Accessibility internationally is facilitated by the text being in both English and Italian (printed in a smaller font size).The species descriptions are meticulously prepared as are observations on ecology and occurrence. Notes of additional species described but not known in Italy are often included, as are references to pertinent revisions and other treatments of particular genera or species. But it is the carefully executed drawings of microscopic features, mainly from material freshly collected by the author and various colleagues, and the colour plates, that together make an immediate impact and will be especially valuable in making identifications. The nomenclature appears to have been carefully checked, with even sanctioning citations used correctly and author abbreviations following the Brummitt & Powell (1992) system recommended in the *Code*. What then could have been improved?: the sketches of perithecia, some of which seem to have been rather quickly prepared and would have benefitted from being reproduced at a smaller size. It would also have been helpful if the figures had been numbered, and might have avoided the embarrassment of some replacement figures having to be sent out with the copies (for pp. 203, 626, and 627).

The preparation of the book has clearly been a labour of love, a tremendous achievement for a family doctor and endocrinologist, and has taken 15 years. Further, the author has been in contact with a staggering 77 mycological specialists around the world and has had the support of some 60 colleagues in securing material for study and illustration. The Associazione Micologica Bresadola is renowned for the quality of its publications and their modest cost, and this tradition is maintained with this splendid volume. As many of the fungi have wide distributions and some occur also on other substrata (e.g. *Chaetomium*) or are rarely to commonly found amongst soil isolates, the book should have an international appeal amongst systematic mycologists and fungal ecologists.

Bell, A. (1983) *Dung Fungi: an illustrated guide to coprophilous fungi in New Zealand*. Wellington: Victoria University Press.

Brummitt, R. K. & Powell, C. E. (eds) (1992) *Authors of Plant Names*. Kew: Royal Botanic Gardens.

Ellis, M. B. & Ellis, J. P. (1998) *Microfungi on Miscellaneous Substrates*. 2nd edn. Slough: Richmond Publishing.

Richardson, M. J. & Watling, R. (1997) *Keys to Fungi on Dung*. 2nd edn. Stourbridge: British Mycological Society.

Fungal Life in the Dead Sea. Edited by Eviatar Nevo, Aharon Oren & Solomon P. Wasser. May 2004 ["2003"]. A. R. G. Gantner Verlag Kommandit Gesellschaft, Ruggell. [Distributor: Koeltz Scientific Books, P. O. Box 1360, D-61453 Königstein, Germany.] [Biodiversity of Cyanoprocaryotes, Algae and Fungi of Israel No. 4.] Pp. 361. ISBN 3 906166 10 4. Price: € 89.

The information gained on the mycobiota of the Dead Sea during the last decade has been impressive, but distributed through numerous separate publications. This multi-authored book covers the history of the Sea's scientific exploration, its origins and physico-chemical characteristics, data on the prokaryotes and algae as background, osmoadaptation strategies, and the fungi themselves. This last topic is the reason the book is mentioned here. Data are presented on the 70 species of fungi recovered from the Dead Sea, together with observations on their diagnostic and cultural characteristics and spatial and temporal occurrences. These are arranged systematically by major group and order, but there is no overall key. References to more detailed accounts of the species are, however, provided. Half-tones of some species are included, and there are colour plates showing colony characteristics of selected species. An impressive 17 page list of publications dealing with microorganisms in the Dead Sea, and a comprehensive index, conclude the work.

The systematic section should prove of some value to mycologists endeavouring to identifying cultures from other saline environments and enable them to compare their results with data now brought together on this most unusual habitat.

Los Hongos de El Edén Quintana Roo: Introduccion a la micobiota tropical de México. By Gastón Guzmán. February 2004 ["2003"]. Instituto de Ecologia A.C., Km 2.5 carretera Antigua a Coeatepec 351, Congregación El Haya, Xalapa 91070, Veracruz, México. Pp. xvi + 316, figs 100, col. plates 189. ISBN 970 709 030 8. Price: Not indicated.

The fungi of Mexico remain poorly understood, especially those species that inhabit the tropical forests of the country. Gastón Guzmán has throughout the years worked tirelessly, endeavouring to right this situation.

This work reports the results of an ongoing biodiversity survey of the poorly known fungi of the El Edén Ecological Reserve, a large forested area to the north of the Yucatan peninsula, Guzmán's *Los Hongos de El Edén* presents a valuable insight into the fungi, including lichen-fungi and myxomycetes of the reserve. This volume represents intensive survey work carried out during early June and November 2000, with the collection of some 700 specimens, comprising macromycetes, some micromycetes, lichen fungi and myxomycetes; some 85% of the collections were new records. Not surprisingly therefore, some of the species treated have yet to be assigned formal species level names.

The volume provides a first-rate account of some 140 species which were collected and are described here. These include 100 basidiomycetes, 20 non-lichenized ascomycetes, ten lichen fungi, eight myxomycetes, two straminipiles, and also mitosporic species, mostly with whole-page colour photographs. Towards the end of the book line, excellent line drawings of microscopic features are provided.

As 'El Edén' has been subject to various forms of disturbance, particularly fires, hurricanes, and deforestation, the book highlights some of the common and new fungi that were recorded from either of these affected habitats.

If there were to be any criticism of the book, it would be the quality of some of the photographs. In a world that is increasingly spoilt by very high quality digital and SLR images of fungi, the few of poor quality within this book may be greeted with some disdain. However, this has to be placed in the context of concern to document what has been actually seen on a particular expedition with the equipment being carried and material presenting at the time.

An excellent bibliography is provided, and one would not want to look further for a sound introduction to the tropical fungi of Mexico. I wish it had been to hand when I first visited Xalapa in 1999. Useful tables of the fungi, including lichenized species and myxomycetes collected by Gastón in such habitats in the country are included, with the species treated and illustrated in the book highlighted in bold. Also valuable is a list of herbarium material deposited by Gastón and his collaborators, along with their accession numbers.

Having spent some time myself in the tropical regions of Mexico collecting macrofungi, and also having interviewed the author for *The Mycophile*, it comes as no surprise that Gastón's unique knowledge of such habitats was indispensible in identifying collections from such an area.

In summary, a very useful volume, forging further inroads into our understanding of tropical fungi, their ecological requirements, and their historic cultural uses for medicines or food. The publishing institute is to be congratulated on having the confidence to produce such a detailed record of the fungi of this site, which will be of lasting value.

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Bolets de Catalunya. Col-Lecció XXII. Edited by the the Societat Catalana de Micologia. 2003. Societat Catalana de Micologia, c/o Institució Catalana de Història Natural, C/ de la Marina 94 1er 4a, ES-08013 Barcelona, Spain. Laminated coloured plates 50. ISSN 0212-3460. Price: Not indicated.

This part continues the format of the last part received by *Mycotaxon* (see *Mycotaxon* **78**: 512-513, 2001) of separate laminated colour photographs with texts on the reverse in both Catalan and Castillion. A huge range of fungi is represented in this installment, which while dominated by agarics also includes resupinates, discomycetes and even a conidial fungus (*Volutella ciliata*). The total number of plates issued in the series is now an amazing 1100, constituting a major aid to identification of fungi in the Iberian Peninsula for those fortunate enough to have complete sets.

Basidiomycetes

Smut Fungi (*Ustilaginomycetes* p.p. and *Microbotryales*, *Basidiomycota*. By Meike Piepenbring. 2003. New York Botanical Garden Press, 200th Street and Kazimiroff Boulevard, Bronx, NY 10458-5126, USA. [Flora Neotropica Monograph No. 86.] Pp. iv + 292, figs 59, photographs 45, maps 54. ISBN 0 89327 449 6. Price: US $ 58.

The smut fungi of the Neotropics are represented in this book by 227 species in 34 genera. The number of host plant species over which these are distributed is 364; these plants belong to 18 families of angiosperms, especially monocotyledons. About 55 % of the hosts belong to *Poaceae* and 17 % belong to *Cyperaceae*. One new species, two new names, and 12 new combinations are proposed.

This monograph will help mycologists and plant pathologists studying this interesting group of parasitic fungi in the Neotropics. The introductory chapters provide general information, valuable both for students and researchers, on the diversity of smut fungi and their recognition and collection in the field, as well as on life-cycles, morphology, distribution, host plants, molecular research, and systematics.

The main body of the book consists of descriptions, illustrations, and keys to the genera and species. Each species description includes nomenclatural data, information on the development of the sori and their morphology, microscopic features of the spores, including wall ornamentation as seen by LM and SEM, germination of the spores (where there is information), Neotropical hosts, distribution in the Neotropics, specimens examined, and illustrations – photomicrographs of spores, and(or) line drawings of symptoms and diagnostic features. The Neotropical distribution of all 227 species is presented on maps. The plates containing drawings and SEM photographs are of high quality and will be appreciated by all readers. Finally, there are lists of references on the literature on Neotropical smut fungi, a list of the host species, and an index of scientific names.

The suprageneric taxa are presented in accordance with the system of Bauer *et al.* (2001), which in turn was based mainly on Bauer *et al.* (1997). However, I would like to point out that the classification of smut fungi and allied taxa has changed since 2001, and that the system of the *Ustilaginales* in particular has altered radically (*cfr* Kirk *et al.* 2001; Vánky 1999, 2001, 2002 a, b). Piepenbring's concept of *Ustilaginales* is too broad according to these newer systems. I also note that the author uses statistical parameters (means with standard deviation) in the species descriptions, based on measurements of a total number of "at least 20 spores" from each collection; 20 is obviously too small a number to examine statistically and ≥ 35 spores would be prudent.

However, there is no doubt that this monograph will be an essential resource for mycologists, plant pathologists, students, and everyone interested in learning about or naming Neotropical smut fungi.

Bauer, R., Begerow, D., Oberwinkler, F., Piepenbring, M. & Berbee, M. L. (2001) *Ustilaginomycetes*. In *The Mycota*. Vol. VII, part B. *Systematics and Evolution* (D. J. McLaughlin, E. G. McLaughlin & P. A. Lemke, eds): 57-83. Berlin: Springer Verlag.

Bauer, R., Oberwinkler, F. & Vánky, K. (1997) Ultrastructural markers and systematics in smut fungi and allied taxa. *Canadian Journal of Botany* **75**: 1273-1314.

Kirk, P. M., Cannon, P .F., David, J. C. & Stalpers, J. A. (eds) (2001) *Ainsworth & Bisby's Dictionary of the Fungi*. 9th edn. Wallingford: CAB International.

Vánky, K. (1999) The new classificatory system for smut fungi, and two new genera. *Mycotaxon* **70**: 35-49.

Vánky, K. (2001) The emended *Ustilaginaceae* of the modern classificatory system for smut fungi. *Fungal Diversity* **6**: 131-147.

Vánky, K. (2002a) The smut fungi of the world – a survey. *Acta Microbiologica et Immunologica Hungarica* **49**: 163-175.

Vánky, K. (2002b) *Illustrated Genera of Smut Fungi*. 2nd edn. St Paul: American Phytopathological Society Press.

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Illustrated Genera of Rust Fungi. By George B. Cummins & Yasuyuki Hiratsuka. 2003. 3rd edn. American Phytological Society Press, 2240 Pilot Knob Road, St Paul, MN 55121-2097, USA. Pp. ix + 225, figs 142 (53 in colour). ISBN 0 89054 304 6. Price: US $ 65.

It is a pleasure welcome this spiral-bound third edition of this standard work; first published by George Cummins alone in 1959, the second edition appeared in 1983 so an up-date was long overdue. I found the Introduction especially well-done, with discussions of relationships, symptom types (beautifully illustrated in colour), and host restriction. A chapter on morphology, life-cycles and cytology follows, again well-illustrated by line drawings and photographs, with an especially fine page of drawings showing surface features, pore arrangements, and shapes of spores. These two first chapters together provide the nucleus for any class on rusts that has to be taught.

In the main body of the text, 133 genera are treated, 120 of which are holomorphic and 13 anamorphic. These are dispersed through 13 families, and clear keys to families and genera are presented. The generic entries themselves are arranged by family, something I find a little irritating as this means that to locate a particular genus either one has to know the family it is now placed in or look it up in the index.

For each genus, publication details are provided along with page-spreads as well as the pages on which descriptions appear, although more than one of those is cited should that extend over several pages. I was pleased to see "in" citations used correctly, but disappointed that the the dates and places of publication of most sanctioned names are given incorrectly; for example *Aecidium* was validly published by Persoon in 1796 and not 1801. Further, "ex" is used rather than ":" where names have been sanctioned for both generic names and species names cited. This is most unfortunate in such an important and widely used reference work, and it is to be hoped that users will not simply copy these citations or presume they are more authoritative than those, for example, in the *Dictionary of the Fungi* (Kirk *et al*. 2001). For each genus, a description, the name of the type species (with basionyms where appropriate), its host, geographical region, remarks, selected literature references, and first-rate line drawings and(or) light or scanning electron micrographs, are all provided.

Appendices cover general and regional literature, author abbreviations, a glossary, and list of generic names and current dispositions. There is also an index including the names of host plants mentioned.

There has been uncertainty amongst rust specialists with respect to the creation and use of anamorph names in rusts where holomorphs are already known. I was pleased to see a firm and pragmatic line taken here. The authors are opposed to both the introduction and use of separate anamorph names for rust species, and instead use phrases such as "uredinia *Uredo*-type" in the descriptions and do not even give the anamorph binomials for species where they have been introduced. At the same time, there is a key to anamorph generic names, together with brief diagnoses, line drawings, and information on the type species, etc. However, somewhat interestingly the new generic name *Petersonia* is formally introduced here for the aecial stages found in three teleomorphic genera of the *Mikronegeriaceae* -- yet although a binomial in *Petersonia* is used for the type species (*Caeoma sanctae-crucis*) the combination is not validly published here nor mentioned under the main text entry of the pertinent teleomorph genus. There is also mention of an "ined." generic name *Wardia* attributed to "J. F. Hennen & M. M. Hennen" for the uredinial stage of the coffee rust *Hemileia vastatrix* and two other genera, but again the binomial is not mentioned or used in the holomorph entry. I believe that there are lessons here for how the nomenclature of other groups of fungi with pleomorphic life-cycles might be increasingly handled in future, whether or not recently made proposals are adopted (Hawksworth 2004). This work should be studied by all mycologists concerned, involved in, or following the current Art. 59 debates (Gams *et al.* 2003).

In summary, a reference work that should be in all mycological and plant pathological libraries, and to which those enquiring about background information on rusts can be directed with confidence. According to the dates of authors included, George B. Cummins becomes a cenentarian in 2004. I and all mycologists will want to send him our best wishes and express our gratitude for all the major contributions he has made to making sense of the world's rusts over so many years.

Gams, W., Korf, R. P., Pitt, J. I., Hawksworth, D. L., Berbee, M. L., Kirk, P. M. & Seifert, K. A. (2003) Has dual nomenclature run its course? The Article 59 debate. *Mycotaxon* **88**: 493-508.

Hawksworth, D. L. (2004) Limitation of dual nomenclature for pleomorphic fungi. *Taxon* **53**: 596-598.

Kirk, P. M., Cannon, P. F., David, J. C. & Stalpers, J. A. (2001) *Ainsworth & Bisby's Dictionary of the Fungi*. 9th edn. Wallingford: CAB International.

Tricholoma **(Fr.) Staude, Supplemento.** By Alfredo Riva. 2003. Edizioni Candusso, Vio Ottone Primo 90, I-17021 Alassio SV, Italy. Pp. 201, col. plates 87, figs 17, tables 1. ISBN 88901057 0 4. Price: Not indicated.

This new supplement to the monograph of *Tricholoma* in Europe [*Fungi Europaei* Vol. 3] which was published in 1988 is an update of information from the same author on additional and new taxa, and supplementary information, to those treated in the monograph. Of the 87 taxa treated here, 20 are updates as either new combinations, or new species, varieties, or forms. Taxa that remain unchanged are cited as with "No modification".

The user has to scrawl through the text with an Italian dictionary to decipher the number of new taxa, combinations, varieties, and forms proposed as this is not given within the guidelines at the front of the book. I did find this somewhat frustrating, so for this review I just gave the number of taxa newly treated (as above).

Updating the systematic-taxonomic details remains based upon the conceptual framework of the 1988 monograph, although some of the authors' interpretations have been modified.

The key, is as in the previous monograph, is based upon gross morphological characteristics placing taxa into various colour groups. If you happen to be in the possession of a copy of the *Methuen Handbook of Handbook,* then the amendments made to the key in the supplement will go some way in addressing problems of subjectivity in colour nomenclature. The additionally recognized new species, varieties and forms have been worked into the key along with any new relevant information applicable to previously treated taxa.

New species, combinations, varieties and forms are accompanied by clear line drawings of pertinent microscopic details. Further, the illustrations that graced the previous monograph have now been replaced by superb colour photographs of the taxa *in situ,* and by a few excellent illustrations by J. P. Beati.

Some author citations are missing dates and further information (e.g. *Tricholoma equestre* var. *albipes* Peck), but in the main are in keeping with the 1988 monograph. There is a new bibliography for the supplement, but for the main bibliography of *Tricholoma,* the user will have to refer to the original monograph.

This is an excellent supplement to the monograph of *Tricholoma* in Europe that reflects the author's desire to present new information garnered during the last 15 years. Information collated from more frequent visits to southern territories during the past decade, and collaboration with colleagues who have a special interest in the genus, make this a major contribution to furthering our knowledge of *Tricholoma* in Europe.

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Rare and Interesting Species of *Psathyrella.* By Eef Arnolds. 10 August 2003. Edizioni Candusso, Vio Ottone Primo 90, I-17021 Alassio SV, Italy. [Fungi non Delineati No. 26.] Pp. 76, col. pl. 8, figs 20. ISSN 1128-6008. Price: € 11.

A welcome addition to the often problematic genus *Psathyrella*, this publication treats 21 species, six of which are described as new here. Descriptions follow the taxonomic arrangement of Kits van Waveren (1985), with respect to the order within the descriptions. All species described, apart from one (*P. granulosa*), are accompanied by excellent watercolour plates. The paintings are based on fresh material collected from an area surrounding the author's house in The Netherlands.

Distinction is drawn between the taxonomic value of the different cystidial types within the genus, and the variation of certain cystidia within a single species. This is a useful aid when approaching microscopic identification of species within this genus. This is helped further by line drawings of the morphological types of cystidia based on the definitions used in the *Flora Agaracina Neerlandica* (Bas *et al.* 1988).

Accompanying each description, are fine, clear line drawings of the important microscopic features applicable to each species. However, the absence of a key of some description is an anachronism, which if included would have been of further help to the user.

In summary, a very clear and useful addition to our further understanding of what is to the field mycologist a confusing and problematic genus.

Bas, C., Kuyper, T. W., Noordeloos, M. E. & Vellinga, E. C. (eds) (1988) *Flora Agaricina Neerlandica*. Vol. 1. Rotterdam: A. A. Balkema.

van Waveren, E. K. (1985) The Dutch, French and British species of *Psathyrella*. *Persoonia, Supplement* **2**: 1-300.

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Osservazioni sul genere *Melanoleuca.* By Robert Fontenla, Mario Gottardi and Roberto Para. 10 August 2003. Edizioni Candusso, Vio Ottone Primo 90, I-17021 Alassio SV, Italy. [Fungi non Delineati No. 25.] Pp. 112, figs 21, col. pl. 40. ISSN 1128-6008. Price: € 14.

Adding to a series of contributions towards our understanding of the genus *Melanoleuca*, this publication presents treatments of 27 species. Nineteen of the species covered herein are complete with full descriptions, explanatory notes of material used, with habitat information as well as additional observations, which with some species include taxonomic notes. Accompanying each species are good quality colour photographs and excellent line drawings of important microscopic features. The remaining eight species, dealt with fully in previous publications, are only provided with new colour iconographs. A newly proposed key, which is simple and easy to use, is included for the subsect. *Exscissae* species currently known in Europe.

Among the 27 species treated, one new species (*M. robusta*) and one new combination are proposed, two species have been neotypified (*M. melaleuca* and *M. robusta*). Further, two species are revealed as present in Europe for the first time, and colour pictures of four species are newly published.

The introduction provides a valuable overview of the macro- and micromorphological features that need to be considered when studying this genus. Further, the section of coloured photographs includes an excellent series of photomicrographs of the various forms of cystidia in certain species, a most helpful inclusion for those studying the genus.

A table showing the taxonomic history of the proposed new species is accompanied by a text providing a useful insight into how species have arrived at their current status. In addition, tables consider other reported species whose status or occurrence in Europe has been challenged.

This is a well-produced and very useful addition to the ongoing contributions of the authors to our knowledge of the genus *Melanoleuca* that will prove to be a very useful tool for all wishing to identify material in or study the genus further.

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Synopsis Fungorum No. 18. Edited by Leif Ryvarden. January 2004. FungiFlora, P. O. Box 95, Blinderen, N-0313 Oslo, Norway. Pp. 84. ISBN 82 907724 29 2. Price: NOK 120.

This is a collection of 12 papers, involving six authors, all on wood-inhabiting corticioid and particularly polyporoid fungi from the neotropics, Ethiopia, Japan, and in some cases other tropical areas. Three new genera (*Globuliciopsis, Lyothelia,* and *Parvodontia*) and 20 new species are described and five new combinations made. There is also a treatment of tropical *Mycoaciella* species (4 spp.), and keys to non-cystidiate *Mycoacia* species (4 spp.), and neotropical species of *Antrodiella* (15 spp.), *Ceriporiopsis* (12 spp.), *Diplomitoporus* (9 spp.), *Oxyporus* (6 spp.), *Navisporus* (4 spp.), *Polyporus* subgen. *Melanopus* (8 spp.) and subgen. *Favolus* (7 spp.). Numerous line drawings showing diagnostic features of newly described and other species are included. In summary, another significant contribution to our knowledge of tropical, and especially neotropical corticioid and polyporoid fungi.

Ascomycetes

Revision of the Genus *Amphisphaeria*. By You Zhi Wang, André Aptroot & Kevin D. Hyde. January 2004. Fungal Diversity Press, Centre for Research in Fungal Diversity, Department pf Ecology and Biodiversity, University of Hong Kong, Pokfulam Road, Hong Kong. [Fungal Diversity Research Series No. 13.] Pp. 168, plates 92. ISBN 962 86765 5 5. Price: US $ 45.

Careful treatments of all names referred to a particular genus are the backbone of taxonomy. With 254 species names referred to it and hitherto no monograph, *Amphisphaeria* was very much a candidate for such arevision. The type material of 170 species has now been examined, and 12 species are accepted in the genus here. Many of the fungi previously placed there proved to be loculoascomycetes and are dispersed through a variety of genera. One new species, one new name, and 27 new combinations are made, only two of which are in *Amphisphaeria*. Genera featuring most strongly are *Arecophila* (5 new combinations), *Didymosphaeria* (3), *Kirschteiniothelia* (5), and *Trematosphaeria* (3). Keys are included not only to the *Amphisphaeria* species but also to those in some of other genera treated in detail (e.g. *Arecophila, Cainia, Ommatomyces*).

Accepted species are described, with details of type and other material examined, and illustrated by photomicrographs showing ascospores, asci, and in some cases the superficial appearance of the ascomata and(or) vertical sections of them. I would have found it helpful to have vertical sections for all species presented, especially those transferred to other genera, as the structures and tissue types are critical in the recognition of, for example, *Kirschsteiniothelia* and *Mycomicrothelia*. For example, I would have particularly liked to see an ascoma section of the species here called *M. lojkae,* which is reported as having the largest ascospores yet described in the genus, especially as no information on the structure of its ascoma is given in the text itself.

Anamorphs are not mentioned, and yet while they are unknown in most species, it would have been of interest to know whether the *Dendryphiopsis* state of *K. aethiops* was present on the names newly synonymized with that species, and if so whether the conidia were in the normal range. I was also intrigued by the exceptionally long-stalked asci figured in *Munkovalsaria donacina* (from the types of two species originally described in *Amphisphaeria*) which make me wonder over the suggested placement in *Dacampiaceae*.

The time to undertake such revisions can be almost open-ended with so many type collections to track down. Inevitably there is a list of some 98 names treated as “untraceable and unexamined species”, amounting to more than one third of all referred to *Amphisphaeria*. Scanning through this list, I noted that the types of quite a few would be expected to be locatable (e.g. all species described by Berkeley, Cooke, Fuckel, Höhnel, and Schweinitz) given the time and opportunity to search different herbaria, while others are quite well-known species currently accepted in different genera (e.g. *A. biformis* is *Anisomerdium biforme, Amphisphaeria callicarpa* is *Caryospora callicarpa, A. pertusa* is *Trematosphaeria pertusa*).

Kevin Hyde is well-known for the high standards of his photomicrographs, and while this reputation is supported by those of the excluded species presented here, those of many of the accepted species are much less crisp and rather grainy. It would also have been good to see the ornamentation or striation in the ascospores of the eight *Arecophila* species accepted more clearly; sadly, these are hardly evident in some of the photographs unless studied with a hand-lens. Otherwise, the book is very well produced.

Such detailed revisions are much-needed as starting points for the identification and naming of fungi, especially when new collections are made in little-studied areas. Having obtained an *Amphisphaeria*-like fungus, hitherto it would have been extremely difficult to progress. Now there is a first port-of-call, and mycologists with packets labelled "*Amphisphaeria* sp." squirrelled away in boxes or drawers will now be able to see if they belong to any of the species treated here. A burst of new activity in describing species in the genus is now to be expected.

***Dothideales* Dictyospóricos/Dictyosporic *Dothideales*.** By Julia Checa. 2004. J. Cramer in Gebrüder Borntraeger Verlagsbuchhandlung, Berlin. [Distributor: E. Schweizerbart'sche Verlagsbuchhandlung (Nägele u. Obermiller), Johannestrasse 3A, D-70176, Germany.] [Flora Mycologica Iberica Vol. 6.] Pp. 162, figs 46. ISBN 3 443 65011 228 49 0. Price: € 58.

It was a pleasure to see an issue of this well-produced series, edited by the Real Jardín Botánico Madrid (Consejo Siperior de Investigaciones Cientificas), devoted to dothideaceous pyrenomycetes with muriform ascospores. Twenty-three genera occurring in the Iberian Peninsula are treated, with keys to both the genera covered and species within those represented by more than one species. Generic and species descriptions are provided, with notes on hosts or substrata and distribution, and pertinent observations. The line-drawings are particularly superb, especially those showing the habit on the natural substratum.

Species reported from the literature are covered even where the material has not been located, but I was unsure why *Dacampia* was missing; three species growing on lichens are known from the Iberian Peninsula (Llimona & Hladun 2001). Where genera include dictyosporous and phragmosporous species (e.g. *Leptosphaerulina*), only the dictyosporpous ones are treated. Full details of types and places of publication of both accepted names and synonyms are included, though it is not always clear whether the types cited have been studied personally by the author. No lists of specimens examined are given, which I found rather surprising in such a work.

I also found it strange in a time when most mycologists have a "whole fungus" approach, not to see anamorphs mentioned at all even under species such as *Pleospora herbarum*. An index to host plants would also have been a welcome addition.

There are the seemingly almost inevtiable nomenclatural slips, for example the repeated citing of places of sanctioning as basionyms with only those bibliographic details and with no mention of the place or date of valid publication of those names. It seems extraordinary that even experienced mycologists cannot get such details correct now 23 years after this aspect of the *Code* was modified. Further, in the case of *Capnodium*, the author citation and place of publication of the genus and type species is given only as "Mont. emend. D. R. Reynolds, Mycotaxon 7(3): 504 [or 505].1978" with no information on the original publication of Montagne. It is unfortunate that the nomenclature was not checked by a specialist as such slips detract from an otherwise painstakingly and well-produced work.

Except for nomenclatural information, the entire text is arranged in two columns, one Spanish and and the other in English. This, along with the fine drawings, makes this a "must-have" for the shelves of all pyrenomycete collectors and specialists. The author should be proud of having generated such a work, and I look forward to further pyrenomycete volumes in the series with similarly splendid drawings.

Llimona, X. & Hladun, N. L. (2001) Checklist of the lichens and lichenicolous fungi of the Iberian Peninsula and Balearic Islands. *Bocconea* **14**: 1-581.

***Hypocrea/Trichoderma* (*Ascomycota, Hypocreales, Hypocreaceae*): Species with green ascospores.** By Priscila Chaverri & Gary J. Samuels. 2003. Centraalbureau voor Schimmelcultures, P. O. Box 85167, 3508 AD Utrecht, The Netherlands. [Studies in Mycology No. 48.] Pp. 119, figs 527 (3 pp. colour). ISBN 90 70351 51 X. Price: € 50.

This work continues the critical revisions of *Trichoderma* and its teleomorphs by Gary Samuels and various colleagues, using a combination of careful microscopic observations, cultural characteristics, and molecular data. Here 124 isolates were used in the molecular phylogenetic studies which utilized two genes, the RNA polymerase II subunit and translation elongation factor 1-α., and both neighbour-joining and Bayesian methods of analysis. The results show the species with green ascospores to be nested amongst *Hypocrea* species with colourless ascospores, and in consequence the genera *Chromocrea* and *Creopus* which had been distinguished by this feature are here treated as synonyms of *Hypocrea*.

Separate keys based on teleomorph and anamorph features are provided to the 40 species accepted here, 11 of which are described for the first time, most from recently collected tropical material. In addition, new names are introduced for 12 *Trichoderma* species for which a name in *Hypocrea* was already available and for one *Hypocrea* that already had a named *Trichoderma* anamorph. While in all anamorph/teleomorph pairs the same species epithets are employed, I really wonder why it was considered necessary to introduce two separate names for the eight new species in which both states were known; while allowable under the *Code*, this is surely contrary to the advice given in Rec. 59A.3 that: "Authors should avoid the publication and use of binary names for anamorphs when the teleomorphic connection is firmly established . . . ".

Trichoderma harzianum s. str. (syn. *T. inhamatum*) is confirmed as anamorph of *H. lixii* (for which an epitype has been designated), and eleven teleomorph names are excluded primarily because type material was unavailable or could not be confidently asigned to any accepted species.

Detailed descriptions of the species are provided and accompanied by line drawings of the anamorphs and half-tone photographs of both anamorph and teleomorph (including sections of stromata and details of the tissue types). In addition, colour plates feature entire stromata and colonies on PDA at 25 °C after *ca* 10 days growth. Attention is also drawn to an interactive key to *Trichoderma* species which is available on http//: nt/ars-grin.gov/taxadescriptions/keys/Trichoderma.

This is carefully executed study, showing the value of combining molecular, morphological and cultural approaches, and which is sure to remain the definitive monograph of the green-spored *Hypocrea* species and their anamorphs for many years to come.

Lichen-forming Fungi

Lichen-forming and Lichenicolous fungi of Fennoscandia. By Rolf Santesson, Roland Moberg, Anders Nordin, Tor Tønsberg & Orvo Vitikainen. 2004. Museum of Evolution, University of Uppsala, Norbyvägen 16, SE-752 36 Uppsala, Sweden. [Available through Svenska Botaniska Föreningen, c/o Växtekologiska avd, Uppsala Universitet, Villavägen 14, SE- 752 36 Uppsala, Sweden.] Pp. 359. ISBN 91 972863 6 2. Price (incl.VAT and handling): SEK 321 (Sweden), 445 (Europe), or 480 (elsewhere).

Rolf Santesson's (1993) carefully prepared checklist of the lichens and lichenicolous fungi of Sweden and Norway has become a constant source of reference on current taxonomy, orthography and author citations to those working on lichenized and lichenicolous fungi world-wide. Since that time there have been many changes and additions, and a checklist has also been published for Finland (Vitikainen *et al*. 1997). With the *Nordic Lichen Flora* launched in 1999 (see *Mycotaxon* **75:** 508, 2000), a single checklist covering all of the Nordic countries would be a logical step. The integration now seen here. embracing three countries, is an important step along that road.

The new edition treats 2844 species, of which 430 are lichenicolous and 27 related saprophytes; these figures compare with 2602, 314, and 17, respectively in the 1993 work. Amongst the related saprophytes, I was pleased to note the long-overdue omission of genera such as *Agyrium, Leptorhaphis* and *Sarea* which are well-known not to be either lichenized or lichenicolous, but which have traditionally and idiosyncratically continued to be covered in lichen checklists and identification works. Yet in this context, I am unsure why *Stenocybe* is retained. The style is similar to the 1993 work, with synonyms (cross-referenced), notes on habitat or hosts, distributions by province within each country, and key literature references.

Many recently described or resurrected genera, mainly of crustose lichens and lichenicolous fungi, are accepted, including *Pseudosagedia* for the *Porina chlorotica* group which was not taken up by Coppins (2002). However, I did not understand why *Usnea subloridana* was not treated as a synonym of *U. florida* despite the overwhelming molecular evidence (which is referenced), why *Nesolechia* was not accepted as distinct from *Phacopsis,* nor why *Punctelia ullophyllodes* was synonymized with *P. subrudecta.* Such *minutiae* and points for further debate between specialists will always arise in such works, and do not detract from the pivotal and authoritative position this work occupies in European lichenology.

Coppins, B. J. (2002) *Checklist of Lichens of Great Britain and Ireland.* London: British Lichen Society.

Santesson, R. (1993) *The Lichens and Lichenicolous Fungi of Sweden and Norway.* 2nd edn. Lund: SBT-förlaget.

Vitikainen, O., Ahti, T., Kuusinen, M., Lommi, S. & Ulvinen, T. (1997) Checklist of lichens and allied fungi of Finland. *Norrlinia* **6**: 1-123.

Svenska Skorplavar och Svampar som växer på dem. By Tony Foucard. 2001. Interpublishing, Taptogatan 4, S-102 53 Stockholm, Sweden. Pp. 392. ISBN 91 86448 42 0. Price: Not indicated.

Tony Foucard's first book on the crustose lichens of Sweden (Foucard 1990) was the first comprehensive treatment to have appeared since the late nineteenth century and included keys and descriptions of some 1350 species. Since 1990 there have been enormous changes in the taxonomy of crustose lichens, and also a new edition of the standard checklist for Sweden (Santesson 1993). That checklist included lichenicolous fungi, and I was especially pleased to see that Foucard's new book also covered the lichenicolous fungi to be found on crustose lichens. In consequence the length has swelled by some 90 pages and around 1550 lichenized and 200 lichenicolous species are now treated. Overall keys to genera are included, the genera are treated alphabetically, and keys provided to species within the genera. The descriptions of species are detailed, and information on the ecology and distribution is included, but generic descriptions are not provided for all genera, mostly ones treated in the 1990 work. Swedish names are given where they exist, and selected literature is cited under the generic entries.

The detailed treatment of lichenicolous taxa is an especially important feature of the book immediately making it of international appeal. Even though in Swedish, the keys are intelligible with the aid of a modest dictionary. I was especially intrigued to see the key to *Stigmidium* with 15 species all keyed out as a 15-chotomy just by their host lichens – a pragmatic approach reflecting how inadequate is our knowledge of species circumscriptions in that genus. A separate list of lichenicolous species arranged by the lichen host is included and in many cases this will be a helpful short-cut when making identifications. The work would have been even more valuable if lichenicolous fungi occurring on non-crustose hosts could also have been incorporated: perhaps that could be considered in any new edition produced?

A double-column format has been adopted this time, which has facilitated the inclusion of the previously marginal and also additional thumb-nail drawings of, for example, ascus apices and spores. One regrettable difference, however, is the omission of the black and white photographs of 345 species which were an especial feature of the 1990 book, constituting the largest collection ever published of photographs of crustose lichens.

A tremendous achievement, and a work which all who deal with crustose lichens and their associated fungi will want side-by-side with its predecessor within reach of the microscope.

Foucard, T. (1990) *Svenska Skorplavs Flora*. Stockholm: Interpublishing.

Santesson, R. (1993) *The Lichens and Lichenicolous Fungi of Sweden and Norway*. 2nd edn. Lund: SBT-förlaget.

Guía dos Liques de Galicia. By Carlos Pérez Valcárcel, Carmen López Prado & Eugenia López de Silanes Vázquez. December 2003. Baía Edicións, Poligono de Pocomaco, 2ª Avda. Parcela G18 Nave Posterior, ES-15190 A Coruña, Spain. [Guía da Natureza Baía Verde No. 13.] Pp. 408, col. plates. ISBN 84 96128 49 0. Price: € 33.28.

This guide to lichens of Galicia is written in Gallego, the romance language of the region. Galicia, in northwest Spain, has a mild, very humid and temperate climate that favours lichen richness and biodiversity in the region. The publication of this guide fills an important gap in our general knowledge of Spanish lichens. The authors made a study of the Galician lichens and provide numerous drawings and photographs that will enable the general public to learn about and appreciate lichens. The book will be of interest to lichenologists in Spain, while particularly serving the needs of beginners. A notable and especially valuable feature is the treatment of the crustose lichens, which other Spanish guidebooks have usually omitted, and the inclusion of detailed photographs of microscopic preparations. It is also well edited and easy to handle.

The guide covers 87 genera and 317 species considered the most representative of this region, including foliose, squamulose, fruticose, leprose and crustose life forms. A key to genera is provided. Genera are arranged alphabetically, and for each genus there is a detailed description together with colour photographs including ons of microscopic preparations of ascomata and spores, where they are present. Keys to species within different genera are provided, and there is a colour photograph for each species treated. At the beginning of the keys there is an explanation of how to identify a lichen, and how to use the guide which will be very useful for beginners.

The first part is well-illustrated with original drawings and colour photographs, and gives a thorough description of lichen thalli: including different growth forms, thallus structures, reproductive strategies, and other characteristic features such as lichen products. The book continues with a section on lichen uses, with an emphasis on their application as bioindicators of air pollution; quantitative and qualitative methods are explained in detail. It also includes a survey of previous lichenological studies in Galicia, to which the present authors and their colleagues have made outstanding contributions in recent years. A glossary and index to taxa is provided at the end of the book.

The quality and number of illustrations will make this book useful even to those with no knowledge of the Galician language.

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A Monograph of *Enterographa* and *Sclerophyton*. By Laurens B. Sparrius. May 2004. J. Cramer in Gebrüder Borntraeger Verlagsbuchhandlung, D-14129 Berlin, Germany. [Bibliotheca Lichenologica No. 89.] Pp. 141, figs 58, tables 2. ISBN 3 443 58068 8. Price: € 48.

This monograph, prepared under the supervision of André Aptroot, treats all species hitherto referred to *Enterographa* and *Sclerophyton* (*Arthoniales, Roccellaceae*). No modern account of these mainly tropical genera has hitherto been prepared, and it is good to see them clearly circumscribed, mainly on the basis of differences in ascospore shape and structure, to accommodate 35 and 14 species respectively. In addition *Sclerophytonomyces* is taken up for *S. circumscriptum* on the basis of the wide paraphysoids and pigmented ascospores, but I remain unconvinced that the name can be treated nomenclaturally other than as a synonym of *Sclerophyton,* the original mention of *S. circumscriptum* merely being due to an error over the citation of the type species of *Sclerophyton,* the intention being to introduce an alternative name for the fungal partner of that genus; a new generic name will probably have to be introduced for that species.

Over one third of the species (18) are described as new to science, most of these tropical and Southern Hemsiphere species of *Sclerophyton*. Ten new combinations are proposed, including two additions to *Llimonaea*. The list of excluded and doubtful taxa has 40 entries, many for species treated as belonging to genera such as *Schismatomma* in other recent treatments.

Descriptions are detailed, there are lists of specimens examined, and clear illustrations of ascospores and black and white macrophotographs showing the habits and appearance of the complex and often cerebriform lirellate ascomata.

A worthy addition to the series, and now the first place to go to identify material of these genera.

Myxomycetes

Myxomycetes of Poland: A checklist. By Anna Drozdowicz, Anna Ronikier, Wanda Stojanowska & Eugeniusz Pamek. 2003). W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland. [Biodiversity of Poland Vo. 10.] Pp. 103. ISBN 83 89648 08 3. Price: Not indicated.

This work is divided into the following chapters: Introduction (History of studies on Myxomycetes in Poland, General remarks on the checklist, Detailed remarks on the checklist, Latin nomenclature, Substrate, Notes, Symbols and abbreviations used in the list), List of species, Outline of systematic classification, Index of Latin names, Index of Polish names (with reference to Latin names), Index of author's names, and References.

The book is very well conceived, the chapters are well structured, and all of them are necessary. I would like to highlight the information presented on the substrate of fructifications, and the very useful notes that facilitate the understanding of different taxonomic interpretations by Polish authors.

The number of species of *Myxomycetes* known from Poland according to this checklist is 222, making Poland one of the countries with major myxomycete biodiversity with respect to described Myxomycetes. However, the historical trajectory of its study has been intermittent, but currently we see again a strong and united team of 'myxomycetologists', something necessary in order to standardize studies and criteria.

It is important to observe that in the checklist are some species described as new for science by authors from Poland or which were originally recognized in the country, such as *Diacheopsis pieninica* Krzemien., *Didymium leptotrichum* (Racib.) Massee, *Didymium macrospermum* Rostaf., and *Enerthenema berkeyanum* Rostaf.

The chapter of References is very interesting because there are works cited in it which are difficult to locate in western European and North American libraries, due no doubt to the former political isolation of Poland. Included are references to works of Raciborski and Rostafińki that can be considered fundamental for the taxonomic study of *Myxomycetes*.

I only missed in this checklist the absence of the complete bibliographic citations of accepted taxa and synonyms, information very useful in any taxonomic work.

In conclusion, the information compiled here is exhaustive and provides what will be a much appreciated tool for all students of *Myxomycetes*, both professionals and amateurs. It is a book that we should include in our libraries.

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MYCOTAXON

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Penultimate revisions

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Revised *Mycotaxon* formatting guidelines

A complete set of the newly revised *Mycotaxon* guidelines will be published in the 2004 October-December issue, 90(2), and posted on www.mycotaxon.com. The new guidelines will condense protocols already covered in *Mycotaxon* 88: 515-526, *Mycotaxon* 89(1): covers 2-3, *Mycotaxon* 89(2): 521, and our website. Below are the most important formatting requirements.

Fonts (General) – Authors **must** obtain permission to use fonts other than Arial [Helvetica], Times [Times New Roman], or Courier (limited to tables where alignment is essential, as in presenting sequence data). Symbol characters (α, β, μm,) should be inserted using the SYMBOLS menu when preparing text in Times New Roman.

Paragraph settings (General) – Authors are encouraged to format paragraphs rather than insert spacer lines or use tab keys to indent (e.g., set spacing at 6-points before, indent first lines by ~1 cm, use hanging indents for literature cited). A formatted MSWord shell setting forth *Mycotaxon*–approved styles is available from the Editor.

The following formats are now required.

Title – *Font:* Arial, 11-point, Bold, **sentence** (not upper or title) case; *Paragraph:* no period (dot) at the end (unless ending with an abbreviation), no indent, center aligned.

Author names – *Font:* Times, 10-point, Roman (regular), Large & small capital; *Paragraph:* no indent, center aligned.

Address information – *Font:* Times, 9-point, Italic; *Paragraph:* no indent, center aligned, no periods at line ends; *Placement:* Email address on top line; Institution/Street on middle line/s; City, Code, Country on bottom line.

Abstract & Key Words headers – *Font:* Arial, 8-point, Bold; *Placement:* on first line preceding text.

Abstract paragraph and Key words list – *Font:* Times, 8-point; *Paragraph:* margins indented ~1cm, no first line indent, fully justified; no period at end of Key words list.

Primary stand-alone subheadings – *Font:* Arial 10-point, Bold/Bold Italic; *Paragraph:* no indent, center aligned.

Secondary stand-alone subheadings – *Font:* Times 10-point, Bold/Bold Italic; *Paragraph:* no indent, left aligned.

Basic Text – *Font:* Times 9- (preferred) or 10-point; *Paragraph:* fully justified (preferred).

Subordinated text – *Font:* Times, 8-point (9-point optional when basic text in 10-point; 7-point optional: preferred in large tables but discouraged in Acknowledgements and Literature cited sections).

Literature cited – *Font:* Times, 8- or 9-point; *Paragraph:* Hanging indent, no line spaces between entries.

Latin scientific names for all taxa up to and including order – *Fonts:* Italic (in the version of the font and style of the sentence or heading containing that name).

Tables – Due to the difficulty of importing complex tables into In-Design, tables are now treated as graphics files. Those submitting MSWord or Rich Text Format electronic manuscripts are asked to submit all but the simplest tables as stand alone EPS or document files during final submission.

Graphic file size – Print resolution in the final publication is 300 dpi and the maximum final print area for a graphic is 11cm wide, 17.5 cm long (without legend). Format high-resolution final graphics files between 300 dpi (line drawings) and 600 dpi (halftone plates). TIF, EPS, and table files should all be scaled to fit the final print area (not page) size.

Submission protocols

Email – Due to increased junk email, authors should always include "Mycotaxon" followed by an appropriate short manuscript title in the email subject header. Authors using spam filters should add <editor@mycotaxon.com> and <llnorvell@pnw-ms.com> to their list of permitted incoming addresses.

Presubmission – When *Mycotaxon* resumes its four volume/year publication schedule in 2005, it will no longer be possible for the Editor-in-Chief to fine-tune each manuscript during the pre-submission period. Authors submitting electronic files for pre-approval are expected to send fully formatted, print-ready electronic files and to implement requested changes themselves. Users of Adobe PageMaker or In Design are encouraged to submit files formatted in those applications. PDF files accompanied by fully formatted MSWord or Rich Text Format files (with graphics removed) can also be used during pre-submission. Those wishing to submit print-quality Adobe PDF files during final submission must be able to insert the masthead font and page numbers after final manuscript approval. Pre-flighting all such files before final submission with Sheridan Press is encouraged.

Final submission is not final until the Editor-in-Chief has received **(i)** ONE (and only* one) manuscript hard copy with all plates, line drawings, and tables in place, **(ii)** a cover letter citing title, number of pages, number of graphics, and addresses (especially email) for **all** coauthors and **both** peer reviewers, and **(iii)** checklists and comments from two peer-reviewers. (Peer-reviewers may email their reviews to the Editor-in-Chief.)

*Authors who submit only print-ready hard copy must **also** submit (i) one print-ready manuscript with half-tone plates omitted but with line drawings and tables included and (ii) separate film-based photographic plates and other items requiring press processing.

Electronic files (which may be sent as email attachments) must include (i) a fully-formatted print-ready document file with graphics (including tables) omitted, (ii) separate high resolution TIF or EPS files for each line drawing, phylotree, or halftone, and (iii) DOC, RTF, or EPS files for each table.

ERRATA

VOLUME 87

p. 76, line 32	for: *floccosa*	read: *floccosum*
p. 76, lines 28 & 32	for: *protracta*	read: *protractum*

VOLUME 89

p. 16, line 21,	*for:* subsecc.	*read:* subsect.
p. 55, Abstract, line 11	for: *stuhlmanii*	read: *stuhlmannii*
p. 89, line 7	for: *effususm*	read: *effusum*
p. 102, line 23	*for:* lead,	*read:* led,
p. 102. line 27	*for:* lead	*read:* led
p. 201, text line 6	*for:* the *Amazonia*	*read:* the genera *Amazonia*
p. 212, line 34	for: *Amyocorticium*	read: *Amylocorticium*
p. 212, line 34	for: *Clavariadeplphus*	read: *Clavariadelphus*
p. 212, line 35	for: *Diplotomitoporus*	read: *Diplomitoporus*
p. 243, lines 43-44	for: *atro virens*	read *atro-virens*
p. 321, Introduction line 12	for: *Tricothelium*	read: *Trichothelium.*
p. 335, line 8	*for:* subsec.	*read* subsect.
p. 336, line 5	*for:* sec.	*read* sect.
p. 336, line 8	*for:* insect.	*read:* in sect.
p. 336, line 9	for: *Anthidepas*	read: *Anthipades*
p. 345, line 36	for: *pinetorm*	read: *pinetorum*
p. 355, Abstract, lines 2, 7	for: *moellerii*	read: *moelleri*
p. 357, Keys, couplet 8b	for: ***moellerii***	read: ***moelleri***
p. 358, line 25	for: *ericacea*	read: *ericaea*
p. 360, line 21	for: *Heterobasidium*	read: *Heterobasidion*
p. 363, last line	*for:* □m	*read:* µm
p. 366, species 6	for: *moellerii*	read: *moelleri*
p. 367, line 1	should read: Figure 5. *Psilocybe moelleri.* A. Basidiome. B. Basidiospores. C. Basidia. D. Cheilocystidia.	
p. 368, Remarks, line 3	for: *moellerii*	read: *moelleri*
p. 387, line 19	*for:* Megasporoporia	read: *Megasporoporia*
p. 389, Abstract: italicize *Antrodiella micra, Aphyllphorales, Hymenochaetaceae, A. pallasii,Trichaptum abietinum,* and *Antrodiella*		
p. 399, Abstract line 4	for: *rubro-stipitatus*	read: *rubrostipitatus*
p. 441, Abstract line 8	for: *clasdosporioides*	read: *cladosporioides*
p. 523, add: *Megasporoporia subcaverulosa* Y. C. Dai & Sheng H. Wu, p. 384		

p. 523, add *Parmotrema sampaioi* Paz-Bermúdez & Elix, p. 506

p. 524, line 6	for: *Transcheliella*	read: *Tranzscheliella*
p. 524, line 7	*for:* p. 83	*read:* p. 82

p. *ii,* the **Editorial Advisory Board** should read

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Mycology owes another debt to Dick Korf for his sympathetic and intelligent editing of this superb work."
Bibliography of Systematic Mycology 10(6): xlviii-xlix. 1998.

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Phaeocollybia in western North America 4: Two new species with tibiiform cheilocystidia and Section *Versicolores* reconsidered[1]

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Abstract — Two new phaeocollybias are described from coastal and coastal montane coniferous forests of California, Oregon, and Washington. *Phaeocollybia rufotubulina,* closely related to the gregarious, hollow-stiped *P. californica* and *P. scatesiae,* differs in pileipellis pigments, pseudorhizal branching pattern, and RFLP profile. *P. tibiikauffmanii* differs from the similarly robust, orange-brown, viscid capped *P. kauffmanii* in its thick-walled narrow-necked capitulate cheilocystidia. Phenetic and cladistic analyses of restriction data generated from thirty-seven isolates representing *P. californica, P. pseudofestiva, P. scatesiae, P. spadicea, P. radicata,* and the two new species support the existence of a clade characterized by thick-walled tibiiform cheilocystidia. Characters previously used to diagnose Section *Versicolores* are re-examined, and the implied phylogenetic separation of the vernal *P. pleurocystidiata* from the fall-fruiting tibiiform western species is discussed.

Key words — *Agaricales,* Basidiomycota, *Cortinariaceae,* ITS, temperate rainforest

Introduction

As part of a continuing study of the genus *Phaeocollybia* begun in 1991, a large number of fresh specimens (>1,000 collections) from Pacific coastal temperate rainforests of western North America have been examined and compared closely with older dried material (including type specimens). During this research, 160 collections were molecularly analyzed (Norvell 1998ab, 2000, 2002; Norvell & Redhead 2000), new insights into the development and biology of the genus gained (Norvell 1998ab), new morphological characters revealed (e.g., the existence of a universal pellicular veil, different pseudorhizal morphologies, the presence of sarcodimitism, see Norvell 1998ab), and seven new species named (Norvell 2000, 2002; Norvell & Redhead 2000). Two additional undescribed species characterized by large ornamented basidiospores, absence of clamp connections, and narrow-necked thick-walled capitulate tibiiform cheilocystidia are described below. Similarities among western North American phaeocollybias characterized by thick-walled tibiiform cheilocystidia are discussed, and Section *Versicolores* (Smith 1957b; Singer 1970, 1986, 1987; Bandala and Montoya 1994) is reconsidered.

---

[1] Based in part on material submitted for a doctoral dissertation at the University of Washington, Seattle WA 98195-5325 USA.

Materials and Methods

Specimen collection and examination, macrochemical tests, DNA extractions, PCR-amplification of the ITS1 + 5.8S + ITS2 rDNA region (henceforth referred to as 'the ITS region'), restriction digests and mapping, and phenetic and cladistic analyses using NTSYS (Rohlf 1993) and Phylip (Felsenstein 1995) were conducted using protocols outlined by Norvell (1998ab, 2000).

Descriptions are based on data taken from both type and other well-documented collections. Morphological and developmental terms (*e.g.* tibiiform diverticula, sarcodimitic tissues, pellicular veil, vertical-monopodial and rhizomorphic pseudorhizae) are explained in Norvell (1998ab). General non-standardized color names in lower case are accompanied by italicized color references. Ridgway (1912) colors are capitalized and abbreviated, with a slash "/" or parentheses separating modifiers of the same base color (*e.g. Mikado /Mars /Verona Brown = Mikado Brown, Mars Brown, Verona Brown; (Pale) Pinkish Cinnamon = Pale Pinkish Cinnamon* and *Pinkish Cinnamon);* bracketed Munsell (1976) alpha-numeric color ranges (*e.g. [2.5Y 6-8/1-4]*) follow Ridgway references. Measurements of anatomical characters were taken from tissues rehydrated in 6% aqueous KOH unless otherwise noted, and basidiospores from the stipe apex were measured when spore prints were lacking. Ranges enclosed in parentheses accompany mean basidiospore dimensions with standard deviations. "L+ll/cm" is the number of lamellae + lamellulae per cm at the pileus "edge" and at the "midpoint" between edge and stipe. "Aerial stipe" refers to the portion of the stipe above the ground; "origin" refers to the pseudorhizal origin at the very base of the basidiome within the substrate.

Herbaria housing cited collections are abbreviated in accordance with Holmgren et al. (1990), with "PNW" representing the Pacific Northwest Mycology Service herbarium. Subscripts denote Randon Fragment Length Polymorphism (RLFP) codes; and asterisks (*) flag Northwest Forest Plan Strategy 1 collections (USDA-USDI 1994, Norvell 1995, Norvell & Exeter 2004) of significance to US governmental forest management policy. Longitudes and latitudes were either converted from Township-Range-Section data obtained from USDI-BLM maps using the TRS2LL computer application (Wefald 1995) or obtained electronically from the Yale Peabody Museum of Natural History GNIS database (YALE). Separate collection dates are not listed for the date-based numbered Norvell (LLN##), Density Management Study (g##), and Chronosequence Study (a##) collections *e.g.* LLN1921116-02$_{\text{ruc1}}$ = Norvell *November 16, 1992* collection 2, RFLP code *ruc1*). Collector abbreviations include RLE or Ex (Exeter), LLN (Norvell), SAR (Redhead), and HDT (Thiers). Vegetation abbreviations include ABGR *(Abies grandis),* ABAM *(Abies amabilis),* BENE *(Berberis nervosa),* GASH *(Gaultheria shallon),* LIDE *(Lithocarpus densicarpa),* OXOR *(Oxalis oregana),* PISI *(Picea sitchensis),* POMU *(Polystichum munitum),* PSME *(Pseudotsuga menziesii),* SESE *(Sequoiodendron sempervirens),* TSHE *(Tsuga heterophylla).*

Taxonomic Descriptions

Phaeocollybia rufotubulina sp. nov. FIGURES 1-2

Pileus usque ad 60 mm latus, convexo-campanulatus, umbonatus, madidus vel viscidulus, glaber, e rufo rufo-brunneus; caro subaurantia; odor leviter florali vel leviter favaceus; lamellae aurantio-cremeae, fulvo-brunnescentes e sporis; stipes usque ad 12 mm versus apicem, usque ad 180 mm longus cum pseudorhiza tenua racemosa, glaber vel fibrillosus, cum corticem tenuissimo, cavus (tubulosus). Sporae longae, 8.2-10 × 4.5-6 µm, limoniformes, rugulosae cum rostro et apiculo glabro et cum plaga obscura; ixocutis cum suprapelle tenue vel moderato, gelatinosa, cum pigmento aurantio incrustato et subpelle cum pigmento intraparietali et encrustato; cheilocystidia abundans, heteromorpha, tibiiformea et 3 µm lata versus septam cum collo crasse tunicato angusto et cum capitulae usque ad 1.5 µm lata, vel clavata leptoderma, gelatinosa, hyalina. Hyphae desunt in texturis omnibus. Typus ad terram in silvis mixtis: LLN1921116-01ruc1, L. L. Norvell cum G. L. Barron et S. A. Redhead (Jackson State Forest, Mendocino County, California, USA). Holotypus WTU; Isotypi DAOM, PNW..

***Etymology**: from the Latin* *rufus* = “reddish” + *tubulus* = “little pipe”

Selected descriptions and illustrations: Norvell (1998a)—color photographs, line drawings. Norvell (1998b)—black & white photographs, line drawings.

Brief summary — Basidiomes densely gregarious, small to medium, more or less uniformly reddish orange; pilei convex-campanulate, subviscid; young lamellae pale orange; stipes strict, tubular with very thin cortices, matte to polished, pale orange to deep purplish red; pseudorhizae sequential-racemose, cord-like, rhizomorphic. Basidiospores large (~9 × 5 µm), long-limoniform, coarsely warty-rugulose with smooth elongated apical beaks, dark orange amber in KOH; cheilocystidia abundant, slightly heteromorphic, thick-walled, refractive, lageniform/tibiiform, occasionally intermixed with thin-walled, mucronate elements; pileipellis bilaminate with a moderately thin yellowish suprapellis composed of narrow hyphae spirally encrusted with orange to orange-brown pigment overlying a thin brownish-orange subpellis; clamp connections absent. Tissues either negative or very faintly pink (pseudorhizae only) in syringaldazine. Dried pileus, colored copper or purplish bronze, with a metallic sheen.

Expanded description — Pileus 15-62 mm broad, convex-umbonate with acute umbo and incurved margin when young, expanding to broadly campanulate with acute to low broad umbo, incurved to straight margin, and incurved edge, glabrous, lubricous to subviscid, opaque, nonstriate, generally bright reddish to brownish orange *(Xanthine / Ochraceous / Apricot Orange, Mars Yellow, Ochraceous Buff)*, often with slightly darker disc and edge *(Sanford’s / Dark Orange Brown, Tawny)*, brownish streaks and damaged areas occasionally present, dried pileus metallic, usually copper or winy-reddish bronze. **Context** 3-6 mm thick at the disc, pale orangish cream *(Pale Ochraceous Salmon, Pinkish Buff)*. **Odor** faintly floral (reminiscent of cultivated *Viola*) or like cooked potatoes (similar to *Amanita citrina)*, occasionally sharply farinaceous after cold storage, then developing a green corn odor on warming. **Taste** mild and not distinctive to slightly bitter (reminiscent of raw potatoes). **Lamellae** nearly free, emarginate with a short tooth, ventricose, multi-tiered with 1-3 (young) to 2-6 (mature) lamellulae irregularly interspersed; 2-5 mm broad (mean length : width ratio 3.5), subcrowded (L+ll/cm: edge = 19-23; midpoint = 10-12); color pale orangish cream *(Apricot / Ochraceous Buff)* when young, maturing to foxy brown *(Clay Color, (Ochraceous) Tawny)* with bright rusty orange streaks.

Primordial sheath remnants present as connective fibrils between pileus and stipe (immature) or as occasional, densely scattered, fine, dark reddish brown fibrils on mature stipe apex. **Stipe** central to slightly eccentric; aerial length up to 140 mm, combined length with pseudorhiza up to 180 mm, apex 4-12 mm diam; strict, terete, uniformly equal except for slight bulbous swelling at ground level above sharply attenuating cord-like pseudorhiza, glabrous and smooth or covered with fine short reddish-orange fibrils, dry to lubricous; apex slightly paler than reddish orange pileus when young *(Xanthine Orange, Light Ochraceous Buff, Cinnamon)*, gradually darkening upwards to a dark reddish to purplish brown in age *(Hay's Russet, Kaiser / Liver Brown)*; hollow, cortex 1-1.5 mm thick, brittle, cartilaginous; lumen empty from pileus to rhizomorphic pseudorhiza. **Pseudorhiza** sequential-racemose, rhizomorphic, 1.5-2 mm thick cord of undetermined length (strands up to 55 mm have been retrieved); cortex dark reddish brown *(Liver Brown, Clay Color)*, cartilaginous; medulla dark orange-brown *(Clay Color)*, compact.

Spore print brown (slightly darker than 7.5YR 4/4 [Sayal Brown]).

Basidiospores 9 × 5 ± 0.6 × 0.3 μm (overall range 8.2-10 × 4.5-6 μm), limoniform with a prominent straight to slightly tilted beak in profile, ovate with swollen portion in face view, exosporium thick-walled, coarsely rugulose roughened except over the apiculus and beak, with less ornamented plage visible in oil immersion; dark to deep orange-amber in KOH; inamyloid. **Cheilocystidia** heteromorphic, with thick-walled and thin-walled lageniform, tibiiform, and clavate elements intermixed; mucronate/ tibiiform elements occasional to frequent, 17-30 μm long with 3 μm wide ventricose bases below 1-μm wide refractive necks and with/without 1.5 μm diam capituli, containing viscous pale to dark amber contents; thin-walled elements less frequent, moderately inflated or broadly clavate, heavily gelatinized, hyaline, developing long filamentous apical outgrowths in age or in storage. **Pleurocystidia** absent. **Basidia** 4-spored, 25-30 × 5-6 μm with long (to 8 μm) sterigmata, hyaline to pale straw-colored. **Pileipellis** a bilaminate ixocutis; suprapellis 120-200 μm thick, the gelatinous matrix pale orange-yellow and the embedded hyphae long, branched, 2-4 μm wide, highly gelatinized, roughened, and with spirally encrusting and intraparietal yellowish-orange to orange brown pigments; subpellis thick (300-450 μm), hyphae (5) 8-15 μm diam, thick-walled, highly gelatinized, walls orange-yellow to deep orange in KOH. **Stipitipellis** a longitudinal ixocutis, hyphae narrow (2-4 μm diam), cylindrical, thick-walled, highly gelatinized, incrusted with medium to dark orange-amber to orange-red pigments. **Tramal tissues** moderately to highly gelatinized, strongly sarcodimitic in the pseudorhiza and lower stipe with long (95- 200 μm), wide ($\leq$ 20 μm), thick-walled ($\leq$ 3 μm), cylindrical, rigid yellowish "vessel" hyphae supported by less conspicuous, shorter (~20 μm), narrower (4-6 μm), branched, thin-walled (< 0.5 μm), flexuous hyphae; in the pileus both hyphal types also present, but vessel hyphae with thinner (1 μm) walls; in the lamellae central hyphae parallel, 4-6 μm diam, highly gelatinized, slightly thick-walled, with refractive septa and pale amber intraparietal pigments; these giving rise to a compact, 2-6 μm thick subhymenium. **Tibiiform diverticula** abundant on mycelium, primordial surfaces, and pseudorhizal pellis; also frequent on vestiges of pellicular veil on stipe apex. **Clamp connections** absent in mature basidiomes but occasionally present in primordial pellis.

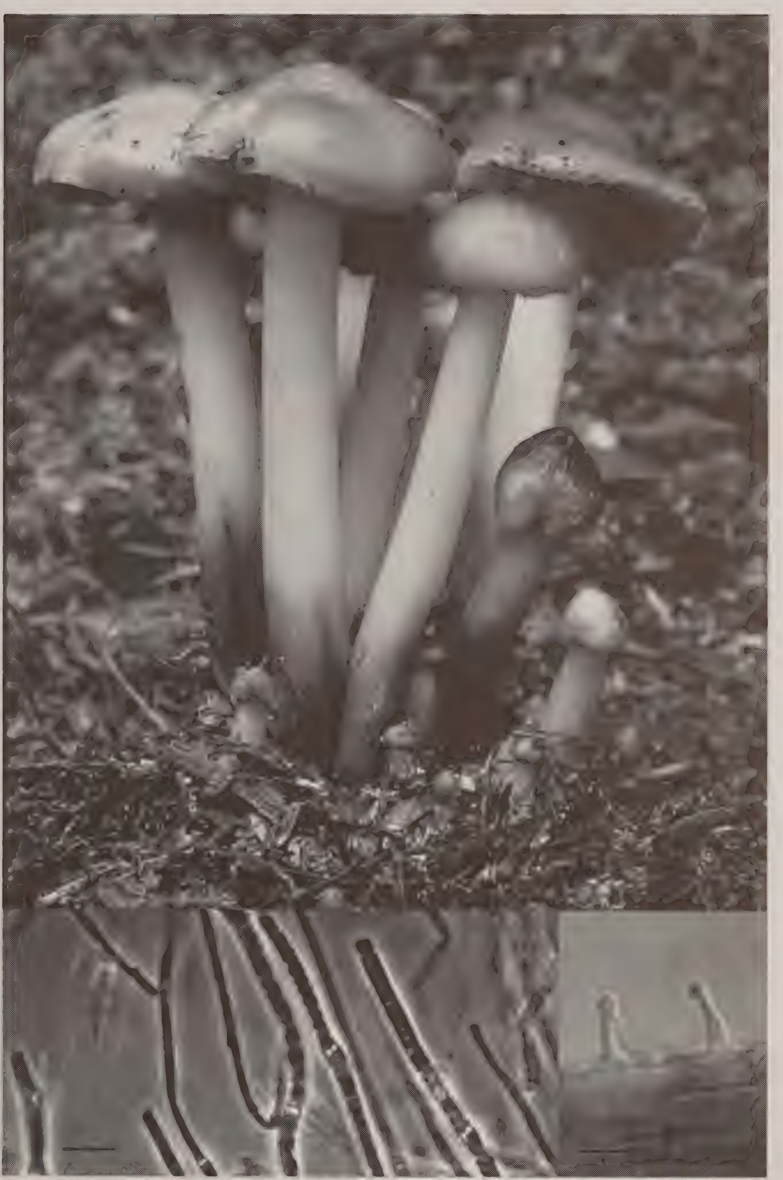

FIGURE 1 *Phaeocollybia rufotubulina* (LLN1921116-01) **1a.** Holotype *in situ* with differentially developed basidiomes in Jackson State Forest, Mendocino County, California (photo by Scott Redhead). **1b.** Suprapellis hyphae with refractive septa and dark orange encrustations (phase contrtast). **1c.** Tibiiform diverticula on stipitipellis (bright field). *Scales = 10 µm.*

Macrochemical reactions — *Syringaldazine* negative to slightly positive (pseudorhiza develops black tinge after 15 minutes and magenta tinge after 60 minutes); *KOH* dark brown on pileus ; $FeSO_4$ slightly greenish on all tissues. **Fluorescence** — (fresh material not checked; dried gills brilliant mustard yellow where mature spores absent. **RFLP profile** (Extensive data for 6 isolates including type) — ITS 690 bp (± 730 bp second band); unique in Xho1 (500-190); EcoR1 (365-325) diagnostic; *also cut* in Cfo1, Hinf1, Nde2, Pal1, and Pvu2; *uncut* in Rsa1, Sal1.

Ecology, range and distribution — Densely gregarious in loose bundles in sandy loam under needle duff in mature mixed forest with an overstory of *Lithocarpus densifolius, Sequoia sempervirens, Pseudotsuga menziesii, Abies grandis* and shrubby understory of *Rhododendron, Vaccinium ovatum,* and *Polystichum munitum.* Uncommon, yet often locally abundant. Known from 13 sites (36 collections) in coastal lowlands from southern Oregon (Lane County) south to Marin County along the north central California coast. October through January.

> **OTHER SPECIMENS EXAMINED UNITED STATES.** California: **Marin Co.** Audubon Canyon Ranch (122.6794°W, 37.19308°N)—05.I.1984 *CCalhoun84-3737* (SFSU as *P. californica*); Bolinas Ridge Tr near Mt Tamalpais (122.7847°W 38.095°N)—clustered in soil under oaks in dense mixed conifer-hardwood forest 17.I.1992 *HDT54067* (sfsu as *P. radicata*); **Mendocino Co.** Jackson SF 'Aleuria Glen' on SF Rd 409, 1.5–2 mi from 408 (123°46'W 39°20'28"N)—mature lide abam psme tshe sese 24.XI.1992 *LLN1921124-02ruc3 -03,-04,-03,-06,-07,-08ruc6,-09,-10,-24,-27* by/w GLBarron REHalling HDT (wtu, -02 -08 split w PNW); Simpson Lane, Fort Bragg area (123.8114°W, 39.4172°N)—duff mixed forest 22.XI.1982 *ASMethven2149* (ny as *P. radicata*); Jackson SF (123°38'52"W 39°23'33"N)—gregarious humus mixed woods 14.XI.1967 *HDT21575* (sfsu as *P. radicata*), 25.X.1986 *MTSeidl2114* (wtu), mature lide abam psme tshe sese 21.XI.1992 *LLN1921121-06-ruc9* by REHalling HDT (ny wtu pnw); Jackson SF near Mendocino (123°47'30"W, 39°18'28"N)—soil mature lide abam psme tshe sese 22.XI.1980 n.c. (*HSC5940* as *P. dissiliens*); JacksonSF jct rds 408/409 'mushroom corner' (123°44'W, 39°19'N)—humus dense mixed forest 25.XI.1960 *HDT08477* (SFSU as *P. attenuata*), 11.XII.1965 *HDT14607* (SFSU as *P. attenuata*), 05.XI.1967 *HDT21404* (SFSU as *P. attenuata*), 07.XII.1969 *HDT24452* (SFSU as *P. californica*), 03.XII.1971 *JFAmmirati06222* (mich as *P. californica*), 31.X.1972 *HDT30427* (SFSU as *P. californica*), 07.XII.1974 *HDT33175* (sfsu as *P. californica*), 02.XI.1975 *HDT35261* (sfsu as *P. californica*), soil sese abam 13.XII.1990 *DEDesjardin5030* (sfsu as *P. californica*), mature lide abam psme tshe sese *LLN1921117-08-ruc8* w SAR (daom pnw wtu); Russian Gulch SP (123°46'26"W 39°19'59"N)—mature lide abam psme tshe sese 25.XI.1992 *SAR7454, 7500ruc7* (daom pnw); Woodlands Camp (123.7050°W, 39.3156°N)—*04.XII.1971 DEStuntz17100* (wtu); **San Mateo Co.** Huddart Roadside Park (122.2947°W 37.4350°N)—duff mixed forest 23.XII.1964 *WJSundberg195* (sfsu as *P. attenuata*); **Santa Clara Co.** Santa Cruz mtns (121°54'W, 37°6'N)—gregarious terrestrial *RAHanks s.n.* (sfsu as *P. attenuata*); **Sonoma Co.** Salt Point SP (123°18'43"W, 38°34'31"N)—mixed woods 25.XI.1972 *HDT30756* (sfsu as *P. californica*). **Oregon: Lane Co.** Florence (124°5'55"W 43°58'58"N)—*LLN1971031-01* Mt Pisgah show (pnw).

Comments *Phaeocollybia rufotubulina* is easily recognized in the field by its striking reddish-orange color, dense gregarious habit, and strict tubular stipe that splits longitudinally and curls back into a floret when sliced crosswise (similar to a dandelion scape). Long, narrow, heavily rugulose-roughened, dark red-brown spores, moderately thick pileipellis with concentrically dark-encrusted hyphae, and heteromorphic mix of abundant thick-walled tibiiform and thin-walled clavate cheilocystidia characterize the species microscopically. No other *Phaeocollybia* species tested possesses an Xho1 restriction site. *P. rufotubulina* appears coastally restricted to southern Oregon (one

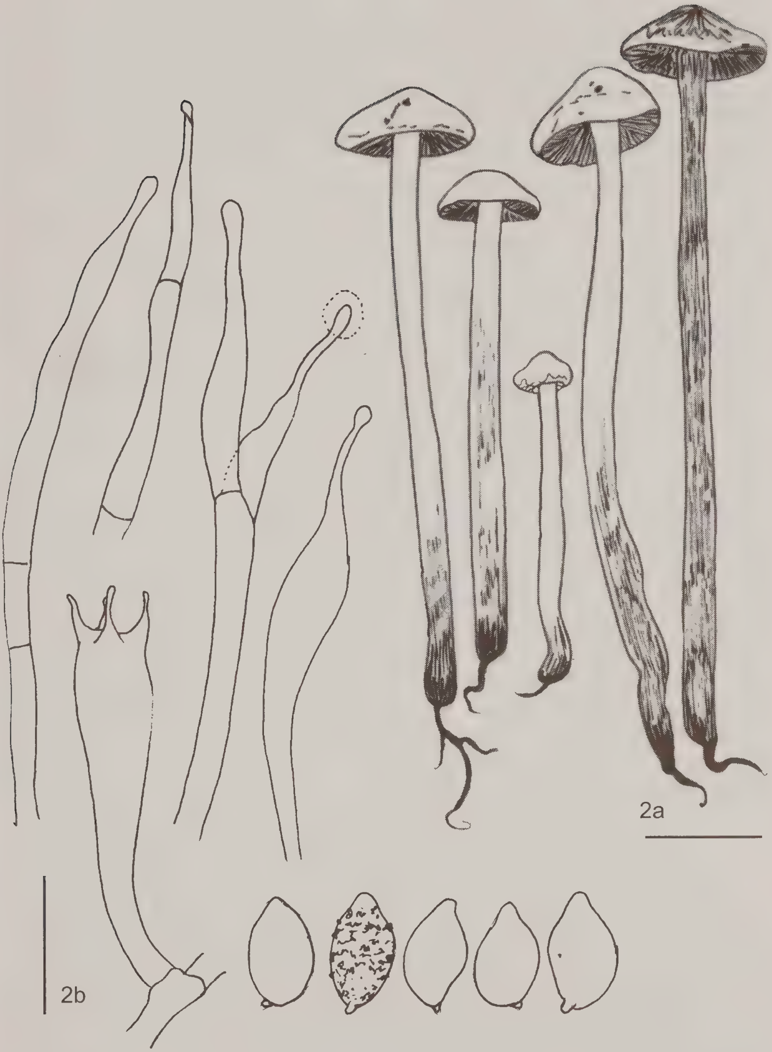

FIGURE 2. *Phaeocollybia rufotubulina* (LLN1921116-01 Holotype WTU; isotypes DAOM, PNW) **2a.** Habit showing sequentially branching cord-like rhizomorphic pseudorhiza. *Scale = 5 cm.* **2b.** Cheilocystidia, basidium, and basidiospores. *Scale = 10 µm.*

collection) and Humboldt, Mendocino, and Marin Counties in California. (For ontogeny and pseudorhizal anatomy, see Norvell 1998b).

A cryptic species previously misidentified as the morphologically similar *Phaeocollybia californica* A.H. Sm., *P. rufotubulina* produces more richly pigmented and strongly ornamented basidiospores, dark orange (not hyaline) concentric encrustations over subtly wider suprapellicular hyphae, a thinner, darker stipitipellis, and more abundant tibiiform cheilocystidia. *P.californica* produces slightly larger, less highly pigmented basidiomes and stipes with thicker cartilaginous cortices lined with long white fibrils

Phaeocollybia rufotubulina and *P. californica* form a complex with another western species, *P. scatesiae* A. H. Sm. & Trappe, previously synonymized with *P. californica* by Horak (1977). All three species share anatomical similarities (basidiospore form and size, cheilocystidia) and possess racemose rhizomorphic pseudorhizae. Molecularly, *P. rufotubulina* is separated by a 10bp length mutation in the ITS region that results in a unique RFLP. *P. californica* and *P. scatesiae,* which have identical RFLP profiles, are differentiated by striking macroscopical and subtle microscopical differences: the densely clustered, highly glutinous *P. scatesiae* basidiomes erupt in fasciculate mounds (usually with scores of tightly clustered basidiomes emanating from single points on subtending rhizomorphic pseudorhizae) rather than in the 'gregarious arcs' of *P. californica*. Additionally, the broadly conic and more sharply umbonate pilei are heavily glutinous and yellowish brown to dark blackish-brown (not subviscid and brownish-orange to orange brown), and the spore prints are a paler brown. Microscopically, *P. californica* is distinguished by its larger, more rounded, darker basidiospores, less abundant cheilocystidia, and 'furred' suprapellicular hyphae (spirally hyaline to pale amber encrusted) with clearly visible, frequently refractive septa. In *P. scatesiae,* the smooth-walled suprapellis hyphae are usually so submerged within a thick gelatinous matrix that individual septa can be seen only with difficulty. *P. scatesiae* is the most widely distributed of the three species, extending from California's Mendocino County the furthest north (to Washington's Olympic peninsula) and farthest inland (to Oregon's Mt. Hood in the Cascades).

Phaeocollybia tibiikauffmanii sp. nov. FIGURES **3-4**

Pileus usque ad 70 mm latus, conico-campanulatus, umbonatus, viscidus, glaber, fulvus vel brunneo-aurantius; caro crassa, pallida; odor leviter florali vel farinaceus; lamellae subaurantiae, subroseo-brunnescentes e sporis; stipes usque ad 12 mm latus versus apicem, usque ad 230 mm longus cum pseudorhiza attenuata, glaber, farctus, versus apicem lamellis subconcolorus, versus subapicem vinascens. Sporae 7.5–9 × 4.5–5.2 µm, limoniformes, verrculosae vel leviter punctatae cum rostro longo stricto glabro usque ad 1.5 µm et cum apiculo excentrico glabro, cum plaga obscura; ixocutis cum suprapelle subcrassa, gelatinosa, hyalina et subpelle crassa cum pigmento intraparietali, infrequens incrustato; cheilocystidia tibiiformeae cum collo crasse tunicato angusto et capitulae 1.5–3 µm crassae vel infrequens clavata leptosperma hyalina. Hyphae desunt in texturis omnibus. Typus ad terram in silvis mixtis Tsugarum et Pseudotsugarum: L. L. Norvell a2011031ox-01 cum R. L. Exeter (Pedee BLM Reserve Forest Chronosequence transect, Polk County, Oregon, USA). Holotypus OSC; Isotypi WTU, PNW.

Etymology: from 'tibi' (< *tibia* = L. for thigh-bone) relating to its tibiiform (ventricose below and capitate above) cheilocystidia and 'kauffmanii' for its similarity to *P. kauffmanii*.

Selected descriptions and illustrations: Norvell 1998a—color photographs, line drawings; 1998b—black & white micrograP.

Brief summary – Basidiomes solitary to fasciculate, moderately large, slightly farinaceous, deeply rooting; pilei orange tawny to brown, broadly campanulate to reflexed, viscid; young lamellae pale orange yellow to pale buff; stipes slender, pale pinkish cinnamon, stuffed with longitudinally splitting cortex surrounding firm to cottony pith; pseudorhizae vertical-monopodial, frequently fasciculate. Basidiospores medium-sized (8 × 4.5 μm), limoniform, roughened, with prominent, smooth, tapered apical beaks; tibiiform cheilocystidia with refractive, thick-walled necks intermixed with thin-walled lageniform and clavate elements; brownish-orange with diffuse pigments; clamp connections absent. Tissues immediately magenta in syringaldazine. Dried pileus copper-colored, sometimes with deep purple red umbo.

Expanded description — Pileus up to 120 mm wide, broadly conic-campanulate with conic to acute low umbo, upturned margin and down-turned straight edge; glabrous, viscid, opaque to slightly hygrophanous, nonstriate; overall brownish orange or foxy brown (*5YR 5/8 – Tawny, Orange Cinnamon*) or with tawny disc and orange cinnamon edge zone, darkening in age *(7.5YR4/2, 10YR 8/4 – Verona, Snuff Brown).* **Context** 4-6 mm at the disc and confluent with stipe pith; color when young pale orangish white *(10YR 9/3),* becoming drab grey in age *(10YR 7/2-6).* **Odor** faintly floral with farinaceous overtones. **Taste** mild, not distinctive. **Lamellae** nearly free, ventricose, thin with ± even edges, polydymous with 3-7 irregularly interspersed tiers, narrow (4-5 mm broad; average length : width ratio = 5.5), close (L+ll/cm = 19 edge, 10 midpoint); color pale orangish buff *(10YR 6-8/6 = Warm Buff)* when young, dull pinkish brown *(5YR 5/6 = Fawn Color)* when mature. **Remnants of primordial sheath** evident as occasional darker fibrillose patches on stipe apex. **Stipe** slightly eccentric, terete, ± equal above, gradually narrowing below toward pseudorhiza; apex 5-12 mm diam, aerial length to 100 mm, combined length with pseudorhiza ≤ 230 mm; glabrous except for darker fibrillose patches, dry, innately longitudinally lined; apex pale to deep pinkish-orange *(7.5 YR 6/5-8; 10YR 7-8/4 = Pinkish Cinnamon, Orange Cinnamon; Warm Buff),* below grading to dull pinkish brown *(5YR 5/6 = Fawn Color)*; cartilaginous rind 2 mm thick, splitting longitudinally in age; stipitipith compact fibrillose, orangish white; **Pseudorhizal form** vertical-monopodial, slightly >2/3 overall stipe length, gradually tapering to pointed origin, origin ferruginous to dark brown *(2.5 YR 4/6-8 = Ferruginous, Sanford's Brown)*; interior pith firm, brown where water-soaked, otherwise concolorous with stipitipith.

Spore print dull pinkish brown (*Fawn Color, 5YR 4-5/4-6).*

Basidiospores 8 × 4.5 ± 0.3 μm (range 7.5–10 × 4–5.5 μm), limoniform with a protruding beaked apex in profile, fusoid-elliptical in face view, verruculose to punctate roughened except on 0.5-1 μm long beaked apex and eccentric apiculus, suprahilar plage an indistinctly bordered area of lowered ornamentation discernible under oil immersion, orange-amber in KOH, ochraceous in H2O, inamyloid (very young spores still attached to basidia faintly dextrinoid in Melzer's). **Cheilocystidia** abundant, lageniform/tibiiform elements abundant, occasionally diverticulate, necks refractive, thick-walled; capituli usually present; occasional clavate elements intermixed, thin-walled; tibiiform elements 17-32 (50) μm long, branched at or above ultimate and penultimate 2-3 μm diam septa, often swelling above septa to 3-5 μm before narrowing to 8–15 × 0.5–2 μm necks, necks either thick-walled and refractive or thin-walled, with or without 1.5–3 μm diam capituli, hyaline. **Pleurocystidia** absent. **Basidia** 4-spored, 27–32 × 7–8 μm, hyaline. **Pileipellis** a bilaminate ixocutis; suprapellis 100–120 μm thick, hyphae radially aligned, 2–6 μm diam, highly gelatinized, hyaline, hyphae within the top 50 μm of suprapellis cylindrical, 2 μm diam, closely compacted and collapsed, in lower portion 2–6 μm wide, thin-walled, often inflated, smooth; subpellis 170–200 μm thick, brownish-orange, hyphae 2–8 μm diam, thin-walled, inflated above refractive septa, with diffuse and often encrusting orange pigments, occasional orange oleifers intermixed. **Stipitipellis** hyphae subgelatinized, thin-walled, long, 2–6 μm diam, pale brownish green (diffuse pigments soluble in KOH). **Pseudorhizal pellis** hyphae 2–4 μm diam, gelatinized, dark orange brown. **Tramal tissues** gelatinous, oleifers present throughout; in the pseudorhiza slightly sarcodimitic, "vessel" hyphae infrequent, only slightly thick walled (≤0.5 μm thick), long, 10–20 μm diam; flexuous hyphae abundant, thin-walled, branched, 2–6 μm wide, irregularly inflating; in the stipe and pileus monomitic; in the lamellae hyphae parallel, 65–80 × 3–6 μm, thin-walled, inflated, subgelatinized, hyaline, toward the hymenium narrowing to 2–3 μm diam and giving rise to a rudimentary subhymenium. **Tibiiform diverticula** abundant on mycelium and pseudorhizal pellis, less frequent on fibrillose pellicular remnants on stipe apex, 4–20 × 0.5–1 μm, hyaline. **Clamp connections** absent in all tissues.

Macrochemical reactions—*Syringaldazine* positive (immediately magenta) on all tissues; *KOH* positive (immediately dark brown); $FeSO_4$ greenish. **Fluorescence**—fresh material not tested; dried lamellae dull yellow orange (one small area in one a brilliant orange yellow)

RFLP profile (Fragmentary data for 1 isolate amplified from outlier Washington collection)—ITS 715 bp; Hinf1 (395-320) diagnostic, *also cut* in Cfo1, EcoR1, Nde2, Pvu2; *uncut* in Rsa1, Xho1; *data missing* for Pal1, Sal1.

Ecology, range and distribution: Solitary to closely gregarious in humus under mature second- and old-growth *Tsuga heterophylla, Pseudotsuga menziesii,* and/or *Picea sitchensis* among *Polystichum munitum, Oxalis oregana, Eurhynchium oreganum.* Known from 13 sites (43 collections) in low-lying to montane areas from Oregon's mid-coast to Washington's Olympic peninsula. October to December.

OTHER SPECIMENS EXAMINED UNITED STATES. OREGON: Benton Co. *Ex200-283* (PNW); **GREEN PEAK BLM DENSITY MANAGEMENT STUDY** (123.4551°W, 44.366°N) — PRE-TREATMENT 'CLEARCUT' 2000' 65yo PSME TSHE POMU *g1981124c1-04* LLN RLE TFennell (OSC PNW); 'HIGH RETENTION' 1900' 65yo PSME TSHE POMU *g1991208hx.03* LLN RLE SAR (PNW DAOM), *g2001127hx3* LLN RLE (PNW); **KLICKITAT BLM UNIT 3** (TRS: 3s7w21NWSW) — 60yo PSME TSHE GASH 30.X.2000 *Ex200-065* (PNW), 16.XI.2000 *Ex200-252* (PNW); **KLICKITAT BLM UNIT 6** (TRS: 3s7w9SWSE) — 50yo PSME TSHE POMU 31X.2000 *Ex200-082,-090* (PNW), 14.XI.2000 *Ex200-187b* (PNW); **KLICKITAT BLM UNIT 7** (TRS: 3s7w21NWNE) — 60yo PSME TSHE GASH 30.X.2000 *Ex200-070* (PNW); **RUNNING BEAR BLM UNIT** (TRS: 13s7w5, 123.5631°W, 44.4686°N) — 200YO PSME TSHE POMU *LLN1981109.108E* RLE (PNW OSC), 6.XI.2000 *Ex200-103* (PNW), 28.X.2002 *Ex2002-16* (PNW). **Lincoln Co. CASCADE HEAD EF,** 100M S TILLAMOOK CO. LINE (123°54'55"W, 45°2'41"N) — late-succ 2nd growth PSME TSHE POMU OXOR *LLN1951109- 19* (WTU PNW); **FOGARTY CREEK SP** (124.0444°W, 44.8425°N) — mid-succ PISI TSHE *LLN1951109-22* (PNW). **Linn Co. BLM CASCADE RA KEEL FLATS** (TRS: 12s1E23) — PSME BENE POMU 6.XII.1999 *Ex199-BK* by KScott 991206-KF-5-KS1 (PNW OSC). **Polk Co. MARY'S PEAK RA BLM UNIT** (TRS: 9s7w1NENW) — 2000' 200yo PSME TSHE GASH 26.XI.2001 *Ex2001-112,115* (PNW); **PEDEE BLM RESERVE CHRONOSEQUENCE STUDY** (123.4885°W, 44.7913°N)

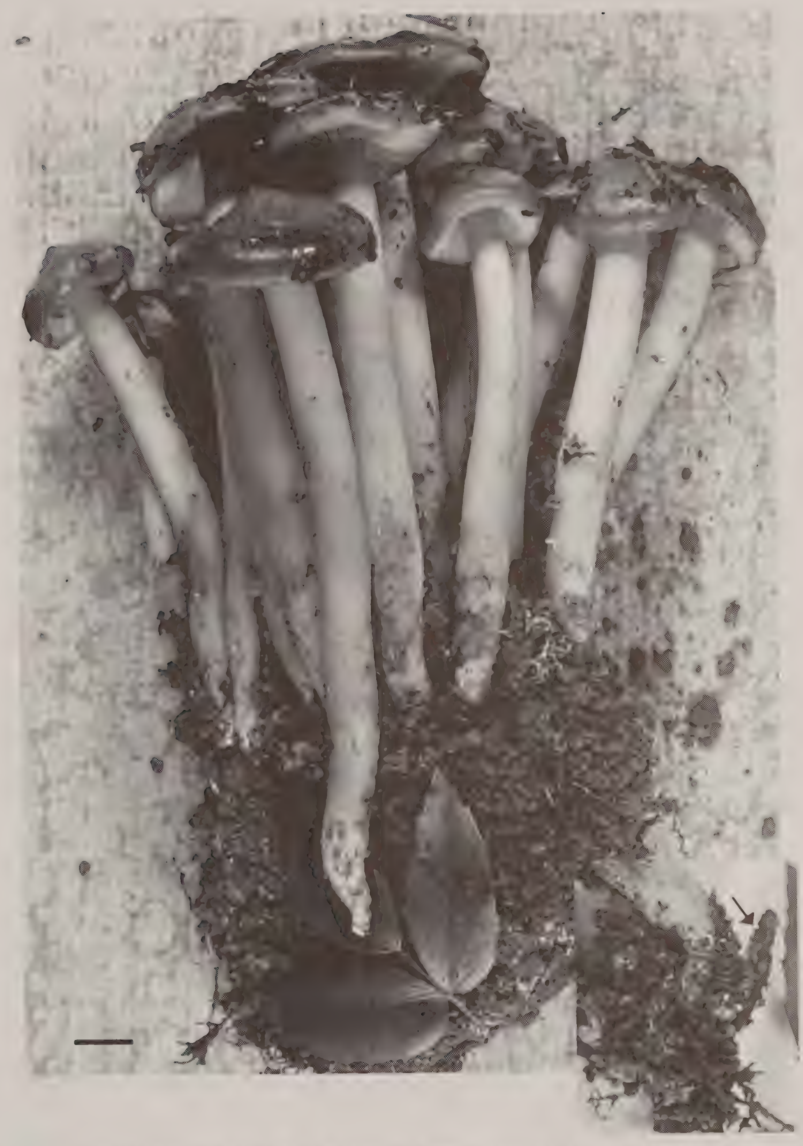

FIGURE 3 *Phaeocollybia tibiikauffmanii* (Holotype. a2011031ox-01). Cluster of primarily mature basidiomes excavated in lab to expose origins of vertical pseudorhizae. *Scale = 1 cm.* Inset: Detail showing new primordium (arrow) arising from fungal mass at excavated pseudorhizal origin.

— **50yo** 1900’ PSME TSHE POMU 1.XI.2000 *Ex200-091* w LLN (PNW); **150yo** 1770’ PSME TSHE POMU *a1981104o1-01 & o2-02–04* LLN RLE CHibbler (PNW), 5.X.2000 *Ex200-045* (PNW), *a2001018o1-15 & o2-25, a2001101o2-30, a2011031o2-03,04,05,06,08 & ox-02, a2011114o1-01,02,03 & ox-01, a2021015o2-01, a2021113o2-01,02,03* LLN RLE (PNW). **Washington: Clallam Co. KLAHANIE CMPGRD, OLYMPIC NF** (124.3000°W, 47.9613°N) — >250yo PISI TSHE *LLN1921018-04*$_{usps3}$ STrudell (WTU PNW).

Comments A tawny, viscid, conic-campanulate pileus, moderately large size, stuffed tapering stipe, medium-sized punctate-roughened basidiospores, heteromorphic cheilocystidia with thick-walled tibiiform intermixed with thin-walled elements, and lack of clamp connections diagnose *P. tibiikauffmanii*. Its size, pileus color, tapering stuffed stipe, vertical-monopodial pseudorhiza, syringaldazine reactivity, and basidiospore size resemble those of *Phaeocollybia kauffmanii* (A.H. Sm.) Singer, but the presence of thick-walled tibiiform cheilocystidia, differences in pigment topography, and absence of heavily gelatinized, strongly sarcodimitic tissues in the pileal trama clearly separates *P. tibiikauffmanii* from the earlier named species. In the field *P. tibiikauffmanii* is differentiated by its more slender aspect and lack of strongly inrolled pileus edge.

Anatomically, *P. tibiikauffmanii* shares affinities with *Phaeocollybia spadicea* A.H. Sm. and *P. pseudofestiva* A.H. Sm. Young specimens of *P. spadicea* are readily differentiated by their dark to blackish brown pilei lacking orange hues, drab stipes usually covered with recurved, agglutinated, cinnamon-colored fibrillose patches, negative syringaldazine reactivity of the pileus and lamellar tissues, and smaller basidiospores. *Phaeocollybia pseudofestiva* — with similar sized basidiospores, tibiiform cheilocystidia, positive syringaldazine reactivity, pileus shape, and odor — is distinguished by smaller olive-green basidiomes with slightly more prominently beaked basidiospores and lacking thin-walled cheilocystidia.

Molecular data for this species were generated from the single Washington collection, initially thought to represent an orange form of *P. spadicea*. The 715 bp ITS region is much shorter than that estimated for *P. kauffmanii*, and the Cfo1, EcoR1, Hinf1 and Nde2 fingerprints support separation of *P. tibiikauffmanii* from both *P. spadicea* and *P. pseudofestiva*.

Cystidial morphology and Section *Versicolores*

There are two distinct cystidial forms represented in *Phaeocollybia*: thin-walled, ≥2 μm diam, cylindrical / clavate elements versus thick-walled, refractive, narrow-necked (≤ 1 μm diam) lageniform / tibiiform elements. Clémençon does not directly address phaeocollybian cystidia in his treatment of hymenomycete anatomy (Clémençon 1997), but the two cystidial types are similar to those he classifies as lamprocystidia and leptocystidia within the non-secretory alethocystidia. Such cystidial classification is, however, complicated by the fact that most western phaeocollybian cystidia both gelify and appear to serve in a secretory capacity.

A. H. Smith, the first to classify *Phaeocollybia* at the subgeneric level (Smith 1957), divided the genus into two sections — *Phaeocollybia,* for species characterized by thin-walled, clavate cheilocystidia, and *Versicolores,* for species characterized by thick-walled, narrow-necked, lageniform to tibiiform cheilocystidia. After finding

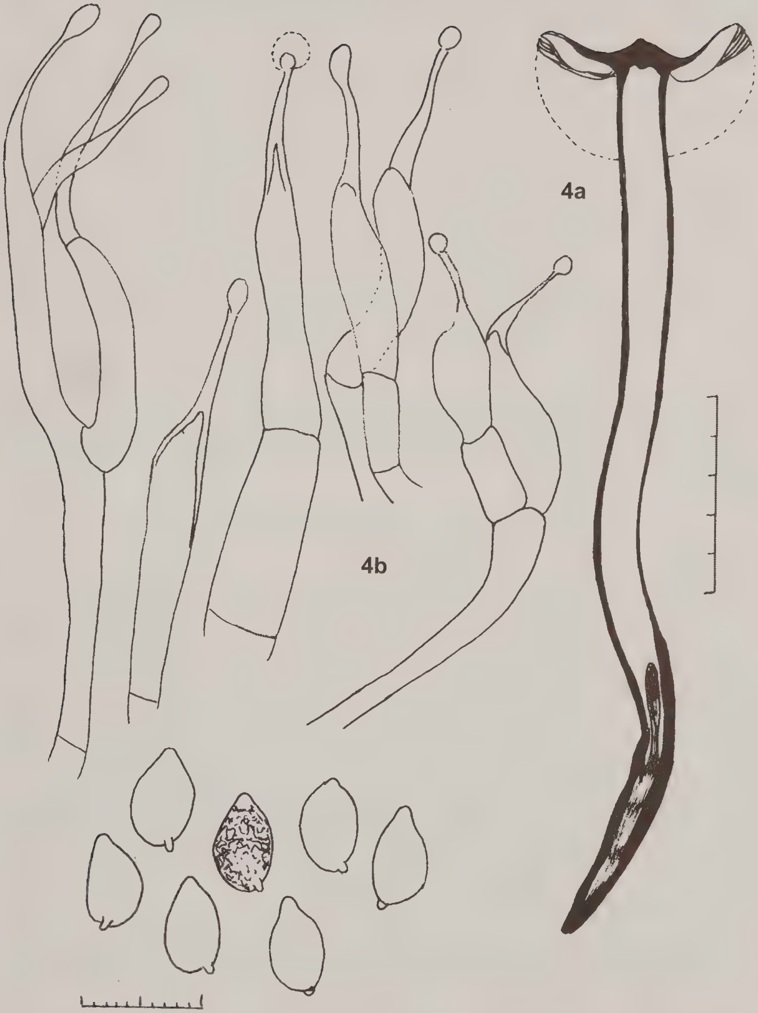

FIGURE 4 *Phaeocollybia tibiikauffmanii* (LLN1951109-19). **4a.** Habit of young basidiome showing lamellar attachment, uplifted pileus, and pseudorhizal form. *Scale = 1 cm*. **4b.** Tibiiform cheilocystidia and basidiospores. *Scale = 10 μm.*

new species from the neotropic western hemisphere, Singer (1970, 1986) revised Smith's sections and added three new ones. Singer separated his sections based on cheilocystidial morphology + basidiospore length + clamp connections:

TABLE 1. *Phaeocollybia* sections sensu Singer 1970, 1986

SECTION	CHEILOCYSTIDIA	BASIDIOSPORE LENGTH	CLAMP CONNECTIONS
Phaeocollybia	clavate to cylindrical	$> 6.5\ \mu m$	—
Subattenuatae	variable, non-capitate	$> 6.5\mu m$	+
Versicolores	acute or apically capitate	$> 6.5\ \mu m$	—
Radicatae	(sub)capitate	$< 6.5\ \mu m$	+
Microsporae	variable; oft clavate / cylindrical	$< 6.5\ \mu m$	—

Most recently, Bandala and Montoya (1994) proposed two subgenera — Subgenus *Phaeocollybia* (with Singer's 'unclamped' sections, *Phaeocollybia, Versicolores, & Microsporae*) and Subgenus *Fibulophaeocollybia* (with Singer's 'clamped' sections, *Subattenuatae & Radicatae*).

Molecular support for section *Versicolores*

Amplification and enzymatic digestion of the ITS region from 160 isolates representing 27 *Phaeocollybia* species and five out-taxa (Norvell 1998a, 2000, 2002; Norvell & Redhead 2000) revealed nine different ITS lengths within *Phaeocollybia* (Norvell 1998a). Most ITS lengths and restriction fragment length polymorphisms (RFLPs) support morphologically based species hypotheses. Table 2 summarizes ITS lengths, number of restriction sites, and RFLP profiles for eight tibiiform species. Although preliminary cladistic analyses of the data obtained from western North American specimens indicate that taxonomic classification at sectional and subgeneric level is still premature, they do imply at least one monophyletic clade diagnosed by cystidial morphology in *Phaeocollybia*. Seven out of eight species characterized by thick-walled cystidia have isolates with relatively short (<715 bps) ITS regions (Table 2). The eighth species (*P. pleurocystidiata*) is, however, characterized by the longer (740 bp) ITS region more commonly found in thin-walled cystidiate species.

While RFLP 'fingerprint' patterns have proved extremely useful for species diagnoses, DNA sequencing should provide more phylogenetically reliable information (*cf.* Norvell 1998a for a discussion of problems associated with inferring phylogenies from RFLP generated data). Cfo1 and EcoR1 RFLP fingerprints for all 160 *Phaeocollybia* isolates show exceedingly subtle differences that are clearly correlated to ITS length variation. EcoR1 halves the ITS regions in *P. californica, P. scatesiae,* and the unallied *P. piceae* A.H. Sm. & Trappe, making the enzyme an effective diagnostic tool, if not a phylogenetically informative one. Hinf1 and Pal1 produce far more informative fingerprints with relatively easily mapped restriction sites. *P. spadicea* isolates have instantly recognizable RFLP profiles that are unique within the genus (Hinf1) or within the thick-walled clade (Pal1). All isolates within this clade have Pvu2 loci and lack Rsa1 loci. Only *P. spadicea* isolates have Sal1 and only *P. rufotubulina* isolates have Xho1 sites. None of the nine tested enzymes produce data that support separation between the *P. californica* and *P. scatesiae* (both with estimated 700 bp ITS regions), two species that are otherwise clearly anatomically and morphologically distinct.

TABLE 2. RFLP-generated data isolated from tibiiform cystidiate western North American phaeocollybias

Species	ITS	Cfo 1	Eco R1	Hinf 1	Nde 2	Pal 1	Pvu 2	Rsa 1	Sal 1	Xho 1
P. californica *(2)*	700	400 300	350 350	355 345	390	465 140 95	610 90	0	0	0
P. pleurocystidiata *(4)*	740	420 320	390 350	390 350	405	**450** **190** **100**	630 80 30	0	0	0
P. pseudofestiva *(4)*	700	400 300	360 340	365 335	405	440 165 95	605 95	0	0	0
P. radicata *(2)*	710	400 310	380 330	390 320	—	**480** **120** **100**	—	—	0	—
P. rufotubulina *(6)*	**690**	400 290	370 320	365 325	400	435 160 95	600 90	0	0	**1**
P. scatesiae *(9)*	700	400 300	350 350	355 345	390	465 140 95	610 90	0	0	0
P. spadicea *(13)*	710	410 300	375 335	**395** **125** **110 80**	**275**	480 120 110	615 95	0	**1**	0
P. tibiikauffmanii *(1)*	715	405 310	380 335	390 325	410	—	625 90	0	—	0

Numbers in each species cell = number of isolates tested. Numbers elsewhere = fragment lengths (in base pairs) estimated per RE (ITS, Cfo1, EcoR1, Hinf!, Nde2, Pal1, PVU2) or number of restriction sites (Rsa1, Sal1, Xho1). RFLP profiles in gray boxes are unique for the 25 *Phaeocollybia* species tested (Norvell1998a); only the top band is given for Nde2. Isolates not cited elsewhere include *Ph. californica* —HOLOTYPE AHSmith55610cal2 (CA) (MICH); *Ph. pleurocystidiata*—HOLOTYPE LLN1940330-02ple1 (WA), LLN1930516-01ple2 (OR), MTSeidl 914ple3 (CA), DAOM128270ple4 (CA) (DAOM); *Ph. pseudofestiva* —LLN1921116-02pse1* (CA), LLN1921121-01pse6 (CA), LLN1911123-02pse8* (OR), LLN1921123-8pse11(CA); *Ph. radicata*—AHSmith3763rad2 (CA) (MICH); *Ph. scatesiae*—LLN1931104-09sca1 (OR), ISOTYPE KScates1136sca2 (OR), LLN1921104-14sca3 (OR), LLN1921123-01sca4 (CA), LLN1921015-19*sca5 (WA), LLN1921015-16*scc5 (WA), HOLOTYPE AHSmith 79286*sca6 (OR) (MICH11630), LLN1931104-02sca7 (OR), CGoetz33sca9* (OR); *Ph. spadicea*—LLN192.11.02-03spd1 (OR), LLN1931023-06spd2 (OR), LLN1921015-26spd3 (WA), LLN1941106-24spg4 (OR), LLN1931104-04sps4 (OR), LLN1921110-22spd5 (OR), LLN1931104-06sps5 (OR), LLN1931114-07spd6 (OR), LLN1931023-07spd7 (OR), LLN1921120-02sps6 (CA), LLN1931114-13spd8 (OR); LLN1921031-03spd4 (WA), [DAOM] LLN1921015-10sps1 (WA). Four additional *Ph. pseudofestiva* isolates from Washington and British Columbia with subtly different banding patterns were not included in cladistic analyses. Collections at WTU unless otherwise noted.

Morphological characters have been mapped onto an unrooted Fitch-Margoliash + Neighbor-joining consensus tree generated from ITS length and restriction site data from 24 *Phaeocollybia* species and *Stagnicola perplexa* (Orton) Redhead & A. H. Sm. (*Figure 5*). Six out of eight 'tibiiform' Pacific Northwest phaeocollybias—*P. californica, P. pseudofestiva, P. radicata, P. rufotubulina, P. scatesiae,* and *P. spadicea*—occur in one clade. Molecular data for *P. tibiikauffmanii* were too fragmentary to include in the analyses. The eighth species, *P. pleurocystidiata,* is unique among western phaeocollybias in its possession of abundant thick-walled tibiiform pleurocystidia. Its additionally distinct vernal phenology (exhibited by only one other western species, *P. phaeogaleroides* Norvell) suggests a possible source for genetic isolation from the seven other thick-walled species, all autumnal fruiters.

The four species at the tips of the autumnal 'tibiform' clade in Figure 5 have subtending, branching, cord-like rhizomorphic pseudorhizae and stipes that soon become hollow. Among other western Phaeocollybias, only *Phaeocollybia dissiliens* A. H. Sm. & Trappe and *P. sipei* A. H. Sm. (also hollow stiped) have been confirmed with cord-like pseudorhizae. Both *P. spadicea* and *P. tibiikauffmanii* (as well as the out-lying *P. pleurocystidiata)* produce basidiomes characterized by vertical monopodial pseudorhizae and stipes always stuffed with firm to spongy pith. Somewhat more problematical is placement of *P. radicata,* which is characterized by clamp connections and extremely small ellipsoid spores. Here molecular data, obtained from only one isolate, were fragmentary and conclusions regarding the place of *P. radicata* within the clade must be considered premature.

Restriction site data do support a clade diagnosed by thick-walled morphology (*Figure 5*). Exclusion of the vernal *Phaeocollybia pleurocystidiata* from that clade, however, challenges Section *Versicolores* as circumscribed by both Smith (1957) and Singer (1970, 1986). Inclusion of the clamped *P. radicata* in the clade likewise challenges Section *Versicolores* as revised by Singer (1970, 1986, 1987) and accepted by Bandala and Montoya (1994). Recent phylotrees containing *Phaeocollybia* sequence data (from the ITS region in Rees et al., 2002, and large ribosomal subunit in Moncalvo et al., 2002, and Rees et al., 2003) offer little insight into sectional relationships within the genus. The phylogeny generated by Moncalvo et al. (2002) from 877 homobasidiomycete taxa (including four north temperate phaeocollybias) recognizes the /phaeocollybia clade in 'euagarics incertae sedis'. The phylotree also supports separation of subgenera *Phaeocollybia* and *Fibulophaeocollybia* as defined by Bandala and Montoya (1994), placing the 'clampless' *P. attenuata & P. redheadii* (Section *Phaeocollybia*) and *P. jennyae* A. H. Sm. (Section *Microsporae*) apart from the 'clamped' *P. dissiliens* (Section *Radicatae*). Rees et al. (2002) included two southern hemisphere representatives—*P. ratticauda* E. Horak (Section *Microsporae*) and *P. graveolens* B. J. Rees & Syme (Section *Radicatae*)—in their preliminary phylogeny of *Gymnopilus* species and related genera, while Rees et al. (2003) included sequences from the south temperate *P. ratticauda* and north temperate *P. jennyae* in their phylogenetic analyses of 78 species from brown-spored genera. While all three phylogenies imply monophyly for *Phaeocollybia,* the omission of taxa representing sections *Subattenuatae* and *Versicolores* leaves the Smith (1957) and Singer (1970, 1986) sectional hypotheses untested. Given the preliminary nature of current molecular analyses, revision of phaeocollybian subgeneric taxa awaits analysis of sequence data representing all five 'traditional' sections from both hemispheres.

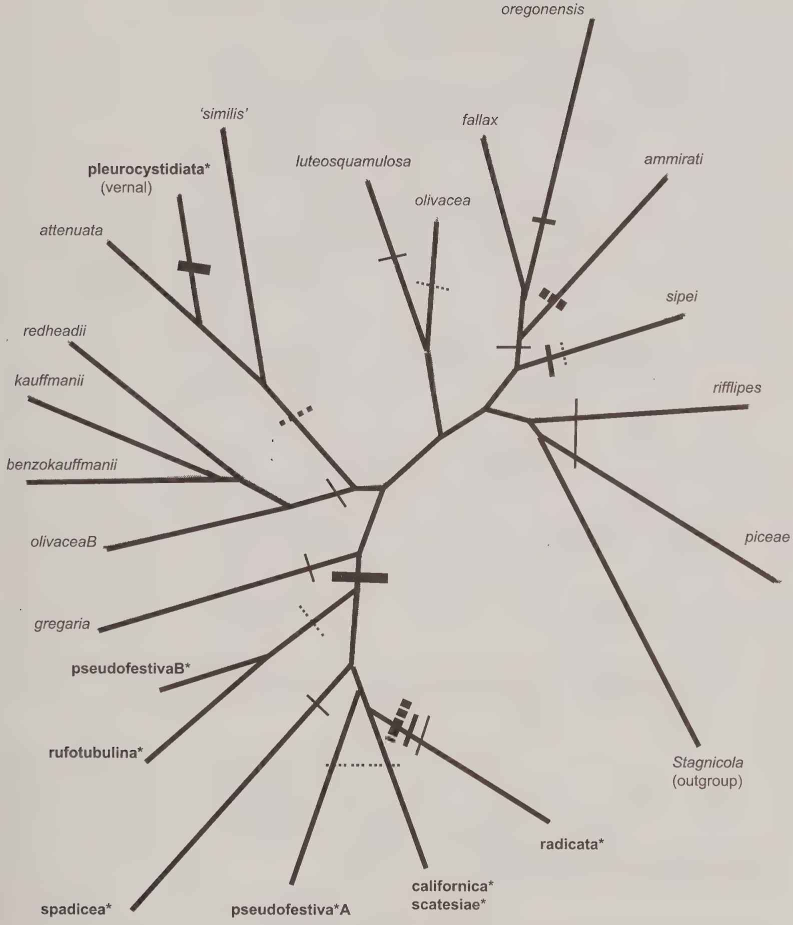
oregonensis
'similis'
fallax
pleurocystidiata*
(vernal)
luteosquamulosa
ammirati
olivacea
attenuata
sipei
redheadii
kauffmanii
rifflipes
benzokauffmanii
olivaceaB
piceae
gregaria
pseudofestivaB*
rufotubulina*
Stagnicola
(outgroup)
radicata*
californica*
scatesiae*
spadicea*
pseudofestiva*A

FIGURE 5 Phylogenetic relationships of 8 tibiiform cystidiate species (bold starred) among themselves and 15 other western *Phaeocollybia* species and the outgroup, *Stagnicola perplexa*, are shown in an unrooted consensus tree generated from Fitch-Margoliash + Neighbor trees derived from ITS lengths and estimated Cfo1, Hinf1, Pal1, Pvu2, Rsa1, Sal1 and Xho1 restriction sites in 150 isolates. Important missing Pal1 and Sal1 data from the only representative tested prevented inclusion of *P. tibiikauffmanii* (not shown), while *P. radicata* (shown) was mapped from suspect molecular data. Sectional diagnostic characters noted above include CYSTIDIAL FORM (heavy bar = thick-walled tibiiform cheilocystidia), CLAMP CONNECTIONS (heavy dashed bar), and SPORE MORPHOLOGY (medium solid bar = small ellipsoid punctate). Lines map differing PSEUDORHIZAL MORPHOLOGIES (solid = vertical monopodial; narrow-dashed = racemose; wide-dashed = criniform lateral-monopodial).

Removal of *Phaeocollybia olivacea* from Section *Versicolores*

One final observation should be made with respect to tibiiform cystidia. Smith (1957), noting their rarity in other genera, felt that refractive, thick-walled, narrow-necked cystidia represented a recently derived form in *Phaeocollybia*. Given their morphological similarity to the generically significant tibiiform diverticula that are an integral part of the primordial pellicular sheath (Norvell 1998ab), however, it seems equally possible that such elements are plesiomorphic and thin-walled cheilocystidia are derived. If so, then thin-walled more or less clavate cheilocystidia could be regarded as modified extensions of the central hyphae in the lamellar trama that have evolved to assume the same secretory functions as their refractive, thick-walled antecedents.

While many western phaeocollybias appear to possess only one cystidial type, others (e.g. *P. rufotubulina, P. spadicea*, *P. tibiikauffmanii)* possess both thick-walled lageniform/tibiiform narrow-necked elements and thin-walled clavate elements. Smith (1957) noted that *Phaeocollybia olivacea* A.H. Sm.—which he described as having thin-walled cystidia—also tends to develop thick-walled 'forerunners'. Bandala and Montoya (1994), who also observed thick-walled elements when they examined the holotype, used this to support their transfer of *P. olivacea* into Section *Versicolores*. My examination of all *P. olivacea* type specimens (Norvell 1998ab), however, uncovered only one specimen bearing heteromorphic cheilocystidia. In that specimen, the far more abundant thin-walled clavate elements were sporadically topped with long thin extensions that were even more rarely capitulate. Thickening of cystidial walls in this specimen was even more rare. I regard the extensions atop the thin-walled elements in this specimen as apical regenerations of innately thin-walled elements—a condition frequently found in old or improperly stored phaeocollybias with thin-walled cheilocystidia (Norvell 1998ab).

Here the infrequent occurrence of thickened walls—again found very rarely in only one type specimen of *P. olivacea*—is more significant than the slightly more numerous presence of narrow-necked (but thin-walled) extensions. In any case, present RFLP data (Norvell 1998a; Figure 5) support exclusion of *P. olivacea* from the thick-walled clade and thus from Section *Versicolores s. a.*

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Trechinothus smardae gen. et comb. nov., un champignon corticioïde à chlamydospores moriformes

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Abstract—*Trechinothus* gen. nov. is proposed to accommodate *Tomentella smardae* recently found again in the Czech Republic and in France. This species is characterized by the echinulate spores with the ornamentation that mostly develops in later stages of spore maturation, the hyphae frequently ampullate at the septa and becoming ochraceous next to the substrate, the absence of any cyanophilous reaction, and the presence of numerous blackberry-shaped chlamydospores in subiculum and on rhizomorphs.

Résumé—*Trechinothus* gen. nov. est proposé pour accueillir *Tomentella smardae*, retrouvé récemment en République Tchèque et en France. Cette espèce est caractérisée par des spores échinulées dont l'ornementation ne se forme entièrement qu'en état avancé de maturation, des hyphes fréquemment ampullacées aux cloisons et qui deviennent ocrées vers le substrat, l'absence totale de réaction cyanophile et la présence de nombreuses chlamydospores moriformes dans le subiculum et sur les rhizomorphes.

Introduction

Un heureux hasard nous a conduits, presque simultanément, à examiner séparément deux récoltes distinctes de l'espèce que nous allons décrire ci-après. L'un de nous (Martini) a eu l'occasion, pour sa part, d'étudier l'holotype de *Tomentella smardae* Pilát, lors d'une visite à l'herbier mycologique de Prague (PRM). Trichies, quant à lui, se voyait confronté à une récolte personnelle dont les caractères lui semblaient alors suffisants pour définir une espèce nouvelle pour la science. La comparaison fortuite de nos observations respectives nous a promptement révélé l'identité spécifique de nos deux spécimens. Dès lors, nous nous sommes appliqués, de conserve, à leur trouver un genre d'accueil satisfaisant.

Ces deux exemplaires montrent un développement quelque peu divergent. Par son basidiome aranéeux, un peu pelliculaire, et ses basides atteignant à peine 25 μm, l'échantillon français évoque indéniablement la structure de certaines espèces du genre *Trechispora* P. Karst. La récolte-type, par contre, rappelle plutôt *Leptosporomyces fuscostratus* (Burt) Hjortstam par son hyménophore plus consistant, membraneux, fragile et séparable du subiculum; elle produit, par ailleurs, des basides près de deux fois plus longues. Par chance, un troisième spécimen attribué à cette même espèce nous a été aimablement transmis par le professeur Zdeněk Pouzar: son développement, sensiblement intermédiaire entre les deux précédentes, nous a permis de supposer que les différences observées à cet égard n'étaient dues probablement qu'à des états distincts de maturation.

Après un examen comparatif approfondi des taxons génériques et spécifiques montrant le plus d'affinités avec *T. smardae*, nous sommes arrivés à la conclusion qu'aucun des genres publiés jusqu'à ce jour ne convenait pleinement à cette espèce et qu'il fallait envisager la création d'un genre nouveau. En conséquence, nous proposons l'adoption de *Trechinothus* gen. nov.

Méthodes

Le matériel sec a été observé à l'aide d'un microscope binoculaire à un grossissement de x 10 en utilisant une source de lumière halogène à fibres optiques. Les couleurs sont codifiées à l'aide du code couleur de Munsell (1975).

Les observations microscopiques ont été faites à partir de petits fragments prélevés à l'aide d'une aiguille ou d'une lame de rasoir, puis montés dans une solution aqueuse de KOH à 2%, dissociés par pression et finalement remontés dans l'acide lactique à 10%. Les mesures ont toujours été effectuées à un grossissement de x 1250 dans ce dernier milieu, celles des spores sont données sans inclure ni l'apicule ni les ornementations. L'observation de l'ornementation des spores à été faite à x 1875. Nous avons observé le matériel dans le bleu coton, le melzer, le bleu de crésyl, le rouge Congo ammoniacal et la solution potassique de phloxine. Des préparations permanentes ont été faites dans l'acide lactique, après dissociation des prélèvements dans une solution aqueuse de potasse. Les dessins ont été effectués à l'aide d'un microscope Nikon Optiphot muni d'un tube à dessiner.

Description

Trechinothus E. C. Martini et Trichies, gen. nov.

Ab Trechispora P. Karst. differt propter sporas ab initio laeves cum parietibus cito crassioribus, magnitudine ultima circiter pervenienti echinulatas.

Etymologie: contraction de l'élément trechi- (allusion au genre voisin *Trechispora*) et du suffixe nothus (faux, bâtard, hybride).

Type du genre: *Tomentella smardae* Pilát

Trechinothus smardae (Pilát) E. C. Martini et Trichies, comb. nov.
Basionyme: *Tomentella smardae* Pilát, Studia Botanica Čechica 5 (1-2) : 75 et tab. X (1942)

Basidiome athélioïde, d'abord aranéeux, moelleux, faiblement pelliculaire, séparable, puis s'épaississant et alors mieux différencié entre strate hyméniale et subiculum. **Hyménium** au début discontinu, poruleux, blanc, blanchâtre (10YR 8/3), enfin continu, compact, membraneux, crustacé et fragile, jaunâtre pâle (2.5YR 8/4) à faiblement ocré (10YR-2.5Y 7/3-4), mesurant jusqu'a 0.2 mm d'épaisseur, facilement séparable du subiculum par petits morceaux, lisse ou rehaussé de petits collicules hémisphériques épars ou plus rapprochés et mesurant jusqu'à 0.2 mm de diamètre. **Subiculum** lâche, hypochnoïde, de couleur claire dans les parties les moins développées, devenant vite écru (10YR 7/2) à gris brun (10YR 5/2) ou un peu plus ocré. **Marge** peu différenciée, déterminée et nette, ou stérile et aranéeuse, et même fibrilleuse ou byssoïde, blanchâtre à beige clair, parfois épaissie et concolore au subiculum. **Rhizomorphes** fréquents à la base du subiculum et dans le substrat sous-jacent, plus rares à la marge, beige clair, minces, jusqu'à 0.1-0.2 mm d'épaisseur, occasionnellement fusionnés et en éventail, atteignant alors 0.4 mm de diamètre.

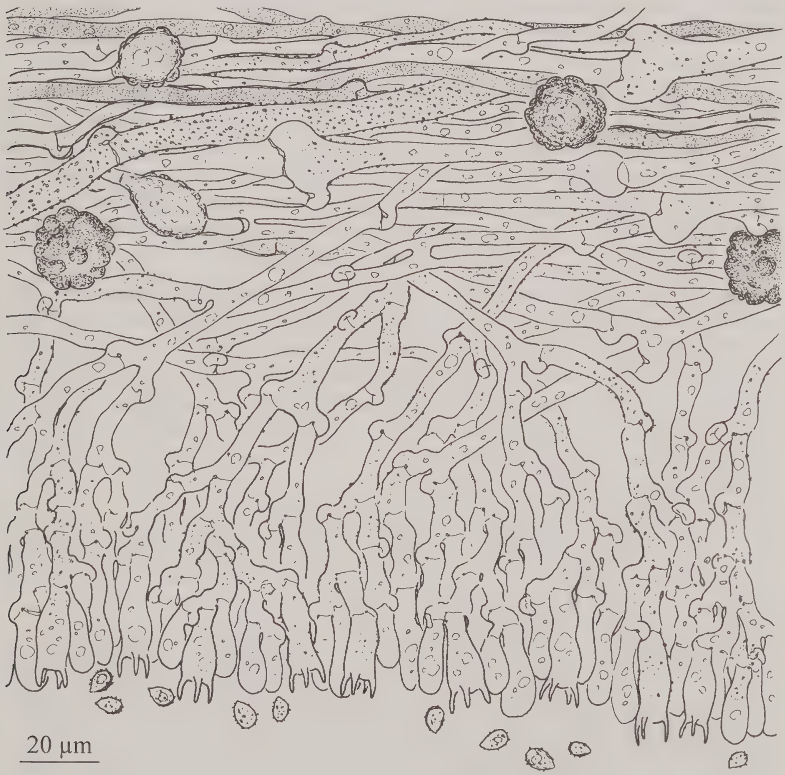

Fig. 1. *Trechinothus smardae*. Section verticale du basidiome, coll. GT 03 092

Chlamydospores facilement visibles au stéréomicroscope comme ponctuations noirâtres dans le subiculum et sur les rhizomorphes.

Système hyphal monomitique. **Hyphes subhyméniales** à articles relativement courts, plus ou moins régulièrement calibrées, mesurant (3) 4-6 (7) μm de diamètre, constamment bouclées aux cloisons, à paroi mince, hyalines, fréquemment ramifiées à partir des boucles, constituant finalement un tissu très compact. **Hyphes subiculaires** très peu cohérentes, à articles généralement longs et de diamètre assez régulier, (2.5) 4-8 (9) μm, mais fréquemment élargies ou nettement ampullacées aux cloisons jusqu'à 13 (18) μm, constamment bouclées, à paroi mince ou un peu épaissie, hyalines ou subhyalines à ocrées. **Rhizomorphes** relativement lâches, avec structure homogène, constitués par un seul type d'hyphes semblables aux subiculaires.

Basides variant sensiblement selon les récoltes: subcylindriques à faiblement claviformes, plutôt trapues et mesurant 15-25 x (5) 7-9 (10) μm dans GT 03 092; subcylindriques à plus nettement claviformes et atteignant 25-40 x 8-10 μm dans PRM 894976; de même forme, voire un peu sinueuses et légèrement plus longues, 30-45 x 8-10 μm dans le type; munies de (2) 4 forts stérigmates à peine arqués mesurant 6-9 μm de longueur et 1.5-2.5 μm de largeur à la base. Basidioles courtement claviformes.

Spores plus ou moins allongées, larmiformes à ovoïdales mais le plus souvent ellipsoïdales, amincies vers l'apicule proéminent, mesurant (5.5) 6-9 (9.5) x 4-6 (6.2) μm, au début lisses ou presque, avec paroi épaissie, ornées à maturité par des aiguillons émoussés ou des verrues régulièrement et assez densément répartis de dimension et de forme assez variables, plus ou moins hémisphériques ou coniques ou subcylindriques, hauts jusqu'à 0.8 (1.5) μm, sans plage lisse sur le côté adaxial, hyalines à faiblement jaunâtres.

Chlamydospores nombreuses dans le subiculum et sur les rhizomorphes, se formant initialement comme cellules ellipsoïdales à globuleuses, sur certaines hyphes assez étroites ou à leur extrémité; d'abord lisses et hyalines mais vite avec paroi épaissie et stratifiée, de couleur jaune à ocre, puis progressivement recouvertes par du matériel résinoïde rouge brun en forme de bulles disjointes ou contigües, de plus en plus grosses, constituant à terme des corps arrondis ou plus rarement ellipsoïdaux, moriformes, de couleur brun foncé, mesurant 18-25 μm de diamètre et jusqu'à 30 (40) x 20 μm pour les exemplaires allongés.

Incrustation: nombreuses hyphes du subiculum et des rhizomorphes (parfois aussi quelques hyphes subhyméniales et quelques basides), fortement à éparsement incrustées par des granules irréguliers, permanents en KOH.

Réactions chimiques: aucun élément cyanophile ni amyloïde.

RÉCOLTES EXAMINÉES — FRANCE, **Meuse**: Billy-sous-Mangiennes, Bois du Blanc Estoc, sur tronc mort cortiqué d'*Alnus glutinosa* et sur la base d'un basidiome vivant de *Ganoderma lipsiense* (Batsch) G.F. Atk., 15.IX.2003, leg. G. Trichies (herb. privé G. Trichies, GT 03 092) — RÉPUBLIQUE TCHÈQUE, **Moravie**: Kuřim, [ad ramulum dejectum putridumque quercinum], 20.X.1941, leg. F. Smarda (**holotype**, PRM 703743); **Bohème centrale**: Karlštejn, in colle Velká hora, declive merid., *Fraxinus excelsior* (ramus iacens) et *Cornus mas* (trunc. vivus), 15.XII.2000, leg. Z. Pouzar (PRM 894976)

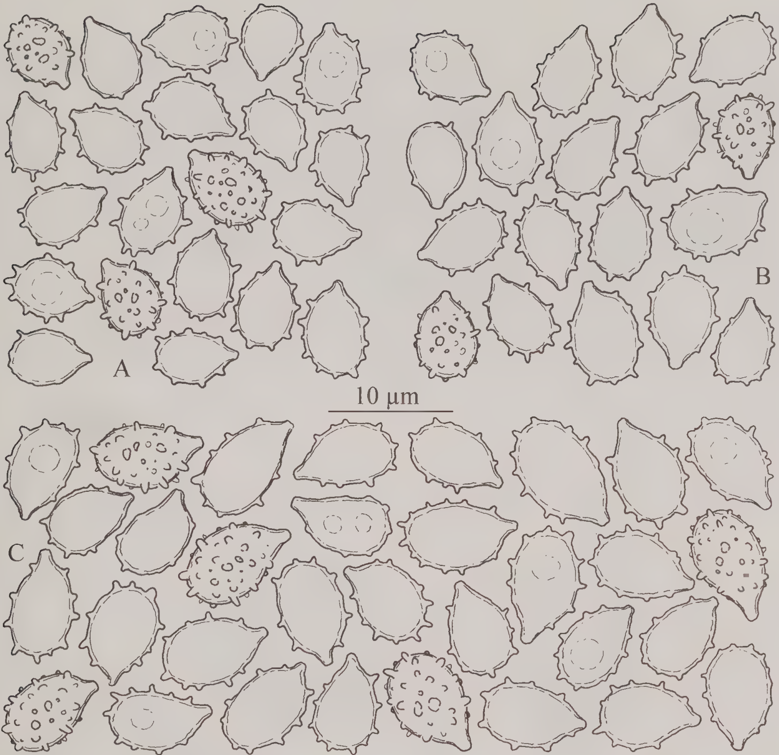

Fig. 2. *Trechinothus smardae*. Spores. **A**. coll. GT 03 092; **B**. coll. PRM 894796; **C**. coll. PRM 703743 (holotype)

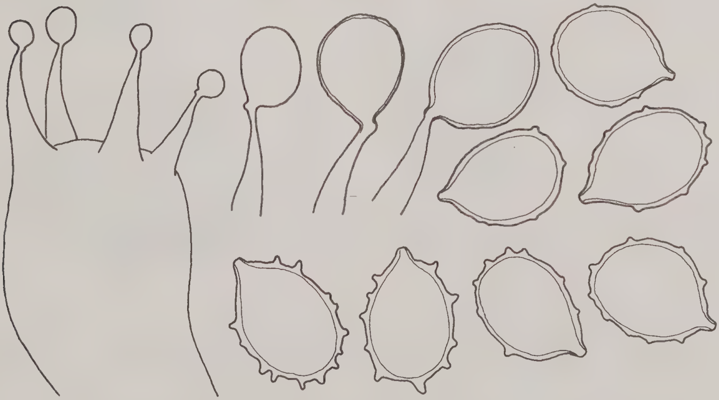

Fig. 3. *Trechinothus smardae*. Ontogenèse de la formation des spores et de son ornementation

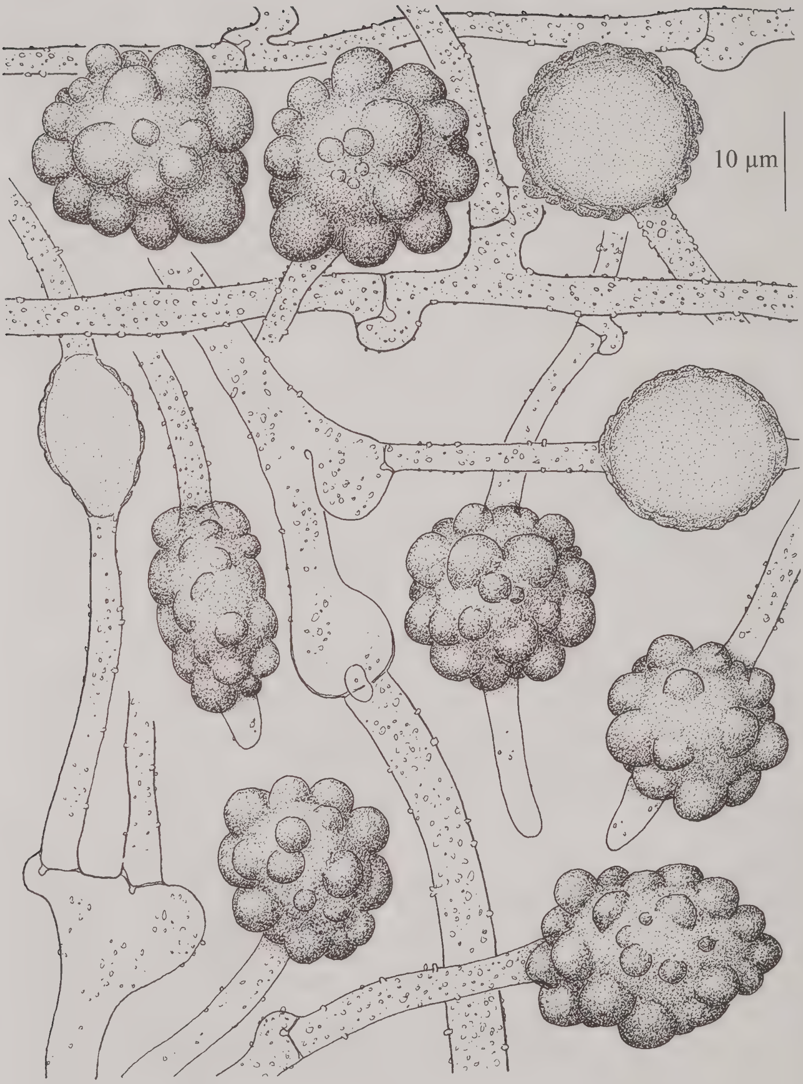

Fig. 4. *Trechinothus smardae*. En haut, trois chlamydospores et hyphes de PRM 703743 (holotype); les autres de la coll. GT 03 092

Discussion

Après la description originale de Pilát, en 1942, nous n'avons pu trouver dans la littérature aucune autre citation de *Tomentella smardae*, hormis une courte note de Liberta (1973) et une autre de Larsen (1974). Le premier auteur mentionne cette espèce, en relation avec *Trechispora polyporoidea* (Berk. & M.A. Curtis) Liberta, qu'il place parmi les espèces exclues de ce genre. Le second la situe aussi à proximité de *Corticium polyporoideum* Berk. & M.A. Curtis (la même note de Larsen se trouve également sur un feuillet daté du 4.IV.1971 et inséré dans l'enveloppe du type de *T. smardae*). Par la suite, ce même *C. polyporoideum* a été transféré dans le genre *Ramaricium* par Ginns (1979) et nous disposons, pour cette espèce, des descriptions de Jülich (1974), de Jung (1987) et de Burdsall (1971) ainsi que des notes de Petersen (1971) qui signalent unanimement des basides pédicellées, une ornementation des hyphes et des spores fortement cyanophile (cette réaction étant plus faible sur les parois correspondantes), des hyphidies dans l'hyménium et enfin, des hyphes basales toujours hyalines et grêles. Nous pouvons donc raisonnablement exclure toute affinité particulière entre *T. smardae* et *R. polyporoideum.*

Trechinothus smardae est un champignon résupiné corticioïde qui concentre certains caractères remarquables mais que l'on peut retrouver aussi, éparpillés çà et là, dans plusieurs autres genres de différentes familles.

En premier lieu, il faut noter la production des nombreuses chlamydospores, phénomène exceptionnel dans les corticiés. Qui plus est, celles-ci ne sont pas de forme banale et nous n'avons connaissance de cellules ornées similaires que dans *Pseudotomentella rhizopunctata*, que Martini et Hentic (2003) viennent de créer, et qui présentent une ornementation craquelée en plaques disjointes. Certaines espèces appartenant à *Sarcodon*, *Hydnellum* et *Phellodon*, produisent également des chlamydospores aux formes singulières et celles de *T. smardae* ne sont pas tellement différentes, à ce point de vue, de celles d'*Hydnellum peckii* Banker dont les bosses sont polygonales et non hémisphériques (Agerer, 1993). Nous sommes intrigués par cette similitude, mais nous n'avons pourtant trouvé aucun autre argument pour établir une quelconque relation de parenté entre *T. smardae* et les *Thelephoraceae* ou les *Bankeraceae*.

Quant aux hyphes ampullacées à de nombreuses cloisons, leur existence est signalée également dans bien d'autres genres qui ne révèlent, dans certains cas, aucun lien de parenté: *Hydnocristella*, *Kavinia*, *Lindtneria*, *Ramaricium, Scytinopogon*, *Sistotrema* ou surtout *Trechispora.* Ce caractère est, en tout cas, très intéressant parce que stable dans les espèces qui en sont pourvues. Parfois, la présence de ces hyphes ampullacées aux cloisons se limite aux rhizomorphes ou bien, elles se montrent rares; dans *T. smardae* elles sont manifestement fréquentes, aussi bien dans le subiculum, que dans les rhizomorphes.

Les espèces du genre *Trechispora* sont celles qui révèlent le plus de similitude avec *T. smardae* et nous avons envisagé clairement son rattachement à ce genre. Ainsi, dans *Trechispora*, il n'est pas rare de découvrir aussi des organes asexués comme des blastoconidies ou des arthroconidies; les hyphes ampullacées y sont fréquentes dans

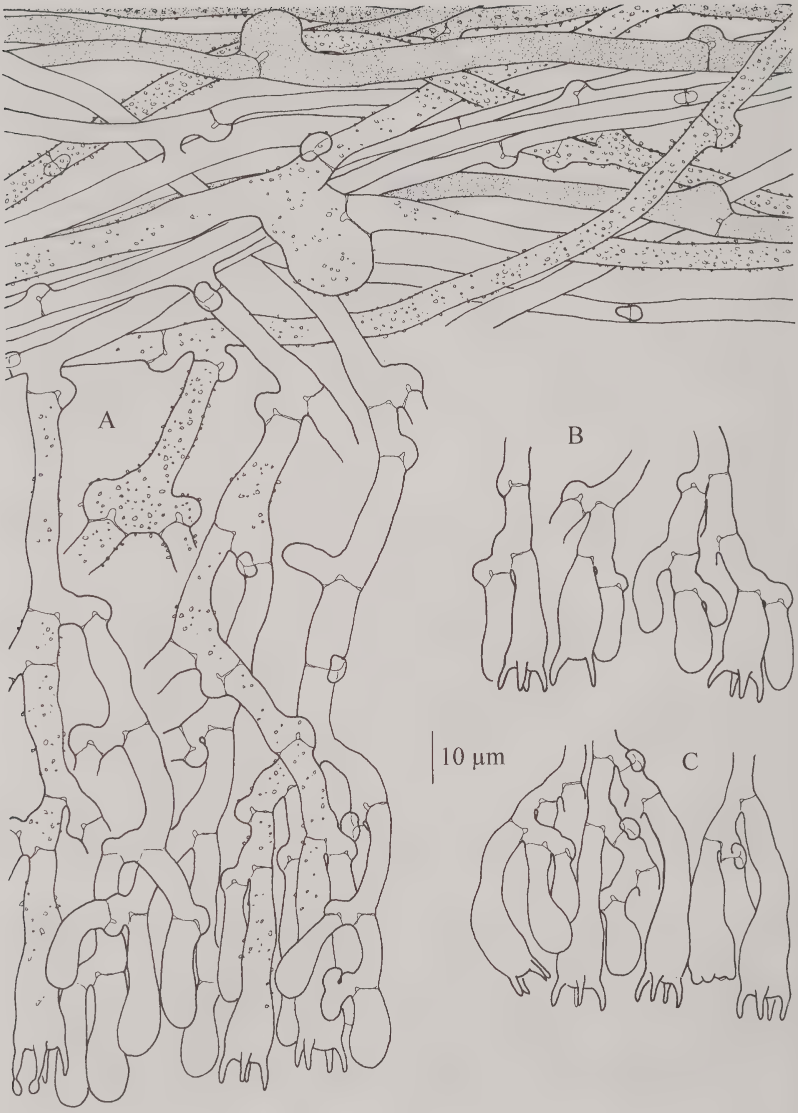

Fig. 5. *Trechinothus smardae*. **A**. Section verticale du basidiome, les hyphes subiculaires finement pointillées sont ocrées, coll. PRM 703743 (holotype). **B**. Basides et hyphes subhyméniales, coll. GT 03 092. **C**. Basides et hyphes subhyméniales, coll. PRM 894976

les rhizomorphes, et les basides ont sensiblement la même forme. Mais les hyphes sont bien plus grêles, les basides normalement plus courtes et les spores beaucoup plus petites, ne dépassant presque jamais 6 µm (ornementation incluse). L'étude minutieuse des spores nous a toutefois amenés à la conclusion que l'ontogenèse de leur ornementation éventuelle est complètement différente. Dans les *Trechispora* ssp. concernés, elle se forme très tôt et peut être observée déjà sur les spores juvéniles encore attachées aux basides et très petites. Larsson (1994: 1167) fait aussi cette constatation: «In a *Trechispora* ornamentation is formed early and can be detected in spores only half the final volume». Dans *Trechinothus*, par contre, c'est la paroi sporique qui s'épaissit d'abord alors que sa surface reste lisse ou presque; l'ornementation ne se forme qu'en état avancé de maturation. Cette évolution nous semble plus proche de celle qu'on observe dans les espèces du genre *Lindtneria*. L'analogie s'arrête pourtant là, car ce dernier possède d'autres caractères distinctement différents de ceux de *T. smardae*. Par exemple, la forte cyanophilie de ses spores dont l'ornementation - par ailleurs nettement dissemblable - présente une couronne crêtée autour de l'apicule qui limite une plage suprahilaire lisse très évidente; mais aussi les basides (et surtout les basidioles) à contenu pluriguttulé pareillement cyanophile; et enfin, la présence seulement exceptionnelle d'hyphes ampullacées aussi typiques aux cloisons, même si des renflements assez considérables s'observent indéniablement le long de certains articles.

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Cladosporium galii sp. nov. on *Galium odoratum* from Poland

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Abstract—*Cladosporium galii* sp. nov. is described and illustrated from living leaves of *Galium odoratum (Rubiaceae)* collected in the Białowieża National Park (Białowieża Forest, Poland). The new species is discussed and compared with morphologically similar *Cladosporium* species.

Key words—mycobiota, mitosporic fungus, Hyphomycetes

Introduction

Cladosporium Link *s. lat.* is one of the largest and most heterogeneous genera of hyphomycetes. A checklist recently published by Dugan, Schubert and Braun (2004) comprises 772 names that have been assigned to *Cladosporium*. The heterogeneity of this genus was discussed by Arx (1983), Morgan-Jones and Jacobsen (1988), McKemy and Morgan-Jones (1990), Morgan-Jones and McKemy (1990) and David (1997). The structure of the conidiogenous loci and conidial hila, examined in detail by David (1997), proved to be a key feature for a more natural classification and circumscription of *Cladosporium*. True *Cladosporium* species are characterized by having 'coronate' conidiogenous loci and hila, i.e., they are more or less protuberant with a central convex dome surrounded by a raised rim (= *Cladosporium* type). This new generic concept was supported by molecular examinations, and the new teleomorph genus *Davidiella* Crous & U. Braun was introduced for species with *Cladosporium* anamorphs (Braun et al. 2003).

The most common, widespread *Cladosporium* species, e.g., *C. herbarum* (Pers. : Fr.) Link, *C. oxysporum* Berk. & M.A. Curtis and *C. cladosporioides* (Fresen.) G.A. de Vries, are saprobic fungi and secondary invaders, but other species of this genus are hyperparasitic or plant pathogenic. A new species, found in Poland on living leaves of *Galium odoratum*, is described, illustrated and discussed in this paper.

Taxonomic Description

Cladosporium* [subgen. *Cladosporium*] *galii *sp. nov.* **FIGURE 1**

Differt a C. cladosporioides conidiophoris saepe fasciculatis et nodulosis, (2.5–)4.5–8(–10) µm latis, et conidiis verruculosis, (2.5–)3–6.5 µm latis.

Etymology: epithet derived from the name of the host genus.

Selected descriptions and illustrations: www.mycotaxon.com (2004) — downloadable PDF file

On living leaves, distinct leaf spots lacking, but with pale olivaceous-brown to greyish discolorations. Colonies hypophyllous, rarely epiphyllous, punctiform, in small tufts, scattered, pale to dark brown, sometimes almost blackish. Mycelium internal, subcuticular to subepidermal, immersed, hyphae branched, (3–)4–8(–10) µm wide, septate, with swellings and constrictions, pale to medium brown, smooth, walls slightly thickened, forming loose to somewhat denser stromatic hyphal aggregations, 37.5–82.5(–100) µm diam., composed of swollen, subcircular, ellipsoid to somewhat angular–irregular, thick-walled hyphal cells, (5–)7–16(–20) µm wide, olivaceous to dark brown, smooth. Conidiophores solitary, arising from hyphae or in loose to dense fascicles arising from stromatic hyphal aggregations, erumpent through the cuticle or emerging through stomata, erect, straight or slightly flexuous, unbranched or rarely branched, 25–280 × (2.5–)4.5–8(–10) µm, septate, but only few septa, subhyaline, pale to medium olivaceous-brown, somewhat paler towards the apex, smooth, sometimes minutely verruculose at the apex, walls slightly thickened, usually swollen und somewhat darker at the base, up to 12 µm wide, often with small, head-like, terminal swellings, up to 8 µm wide, with a single or several distinct scars at the apex. Conidiogenous cells integrated, terminal or intercalary, cylindrical or often with small swellings, 18–80 µm long, proliferation sympodial, with a single or few conidiogenous loci, loci protuberant, mostly short cylindrical, (1–)1.5–2.5 µm wide, slightly thickened, darkened–refractive (*Cladosporium* type). Conidia catenate, in simple or branched acropetal chains, sometimes solitary, straight to slightly curved, conidia small, obovoid, ellipsoid, 3–7 × 2–4 µm, smooth, ramo-conidia ellipsoid, fusiform to cylindrical, 6–30(–40) × (2.5–)3–6.5 µm, mostly 0(–2)-, very rarely 3-septate, not constricted at the septa, subhyaline, very pale to medium pale brown, smooth to usually minutely verruculose, walls only slightly thickened, somewhat rounded at the ends, with protuberant hila at one end or both ends, slightly convex, (0.5–)1–2.5 µm wide, with a central convex dome, surrounded by a raised fine rim.

Cladosporium pilicola Richon (Saccardo 1892: 602) was described from France on dry stems of *Galium mollugo*. Type material of this species could not be traced, and other collections are unknown. However, based on the original description, *C. pilicola* is quite distinct from *C. galii* (probably saprobic; conidiophores branched; conidia cylindrical, 1–3-septate).

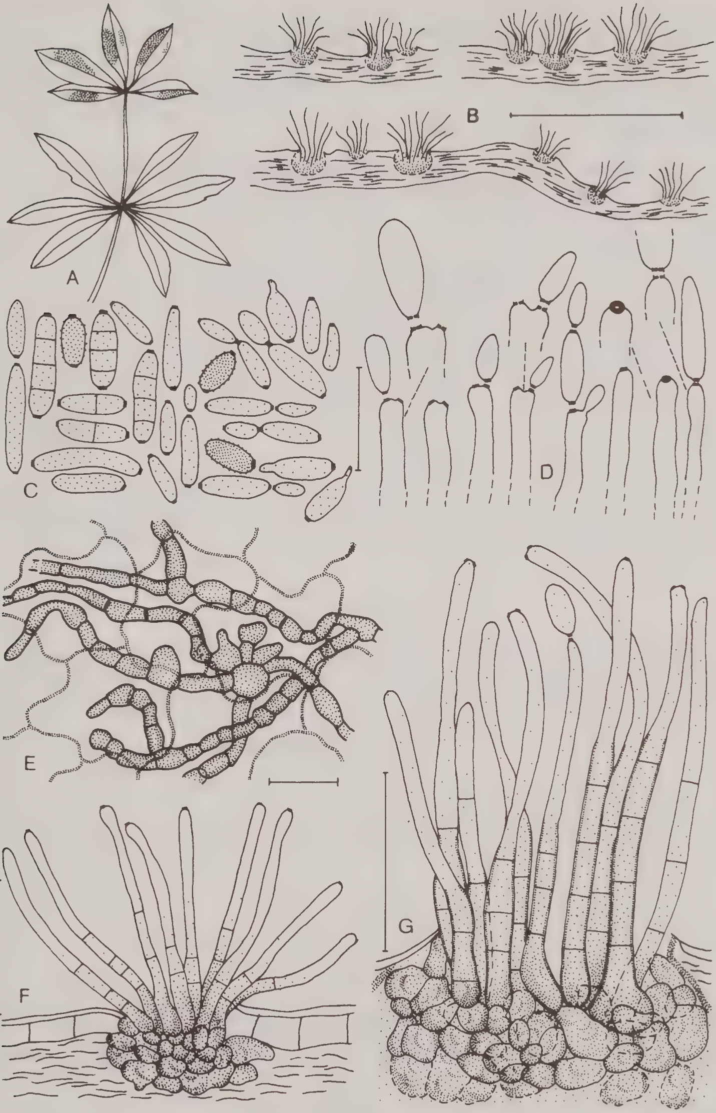

Fig. 1. Morphology of *Cladosporium galii*: A – infected young leaves (orig. size); B – section of the leaves tissues with stromata and conidiophores (bar = 500 μm); C – conidia (bar = 25 μm); D – apices of conidiophores (bar = 25 μm); E – vegetative subepidermal mycelium (bar = 60 μm); F – scheme of a small stroma with conidiophores (bar = 100 μm); G – big stroma and conidiophores (bar = 50 μm).

The common, widespread *Cladosporium cladosporioides* (concept based on Ellis 1971 and Ho et al. 1999) is usually a saprobic fungus or secondary invader on many different plants, but plant pathogenic races may also occur. This species is morphologically close to *C. galii*, but differs in having narrower, cylindrical conidiophores, 2–5.5 μm wide, without swellings, usually formed singly, and usually smooth, narrower conidia, 2–5 μm wide (Ellis 1971, Ho *et al*. 1999).

Nodulose conidiophores are known from some other *Cladosporium* species, e.g., *C. colocasiae* Sawada, *C. herbarum s. lat.* (incl. *C. macrocarpum* Preuss), *C. oxysporum* and *C. variabile* (Cooke) G.A. de Vries (Ellis 1971). The conidia of *C. herbarum s. lat.* and *C. variabile* are coarsely verruculose and wider. In addition, *C. variabile*, confined to *Spinacia oleracea*, is well-distinguished by forming tortuose, spirally twisted aerial hyphae. *C. colocasiae*, a common parasite of *Colocasia* species, has much wider (6–9 μm), smooth conidia, and the widespread saprobic species *C. oxysporum* differs in having very long conidiophores, up to 500 μm or more, and smooth conidia. Various species of *Cladosporium* subgen. *Heterosporium* (Klotzsch ex Cooke) J.C. David tend also to be somewhat nodulose (David 1997), but they are easily distinguishable by having much larger, above all wider, verrucose conidia, which are usually formed singly.

REPRESENTATIVE SPECIMENS EXAMINED – **POLAND**: Nizina Północnopodlaska, Białowieża Forest, Białowieża National Park, Forest Compartment 342, Permanent plot No 40 of Białowieża Geobotanical Station of Warsaw University, single collection on living leaves of *Galium odoratum* (L.) Scop. (Rubiaceae) in oak-linden-hornbeam forest (*Tilio-Carpinetum*), 26 Sept. 1992, leg. W. Mułenko, [HOLOTYPE – LBLM 8459, ISOTYPE–HAL 1811 (F)].

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Thozetella buxifolia sp. nov. — a new hyphomycete from Argentina

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Abstract—Current research on fungi growing on decaying leaves in a native xeric forest dominated by *Celtis tala* and *Scutia buxifolia* has uncovered a previously unpublished new species. *Thozetella buxifolia* is described, based on observations on natural substratum.

Key words—imperfect fungi, hyphomycetes, litter

Study area

The native dry forest dominated by *Celtis tala* Gill. ex Planch. and *Scutia buxifolia* Reiss. constitutes the main woodland community of the eastern plains ("Pampa") in Buenos Aires province, Argentina. The forest grows on highly calcareous material derived from sea transgression and regressions in the Quaternary (Cabello & Arambarri 2002).

Reports on the litter fungi of this native woodland have not been published, although there is a previous report on biodiversity of soil fungi (Cabello & Arambarri, 2002). At present, a new representative of the Hyphomycetes isolated from fallen leaves of *Scutia buxifolia* is described.

Introduction

Thozetella O. Kuntze (1891) is a nom. nov. for *Thozetia* Berk. & F. Mueller (in Berkeley, 1881) and was revised by Pirozynski & Hodges (1973) who accepted four species. Subsequently additional species were described by Nag Raj (1976), Holubová-Jechová & Mercado Sierra (1984), Sutton & Cole (1983) and Mercado Sierra et al. (1997) being nine at this moment the described ones. The genus is characterized by aseptate, hyaline, curved conidia, each end with an unbranched setula, phialidic conidiogenesis and integrated conidiogenous cells. Distinctive elements that Pirozynski & Hodges (1973) called microawns (to indicate their morphological similarity to awns of certain *Gramineae*) are formed in conidiomata and these are unique for *Thozetella*.

The type species *T. nivea* (Berk.& Muell.) Kuntze has sporodochial conidiomata as do *T. canadensis* Nag Raj and *T. cubensis* Castañeda et Arnold. *T. effusa* Sutton & Cole forms a flat conidioma with 1-2 cells thick on the outer face from which conidiogenous cells are produced. Whereas in *T. radicata* (Morris) Pirozynski & Hodges, *T. tocklaiensis* (Agnihothrudu) Pirozynski & Hodges, *T. cristata* Pirozynski & Hodges, *T. ciliata* (Castañeda) Hol. Jech. & Mercado, *T. havanensis* Castañeda and *T. buxifolia* Arambarri, Cazau, Cabello & Allegruci the conidiomata are simply synnematal, occasionallly becoming branched towards the apex.

T. effusa Sutton & Cole forms a flat conidioma with 1-2 cells thick on the outer face of which conidiogenous cells are produced. In *T. radicata* and *T. tocklaiensis* the conidiomata are only known from culture. In *T. ciliata* there are not microawns and the synnema has black setae. Pirozynski & Hodges (1973) considered that *T. ciliata, T. tocklaiensis* and *T. radicata* are geographical variants or growth forms of the same species.

Taxonomy

***Thozetella buxifolia* sp. nov.** **FIGURE 1 (A-C)**

Etym.: buxifolia, *referring to* Scutia buxifolia *where the fungus was found.*

Synnemata dispersa, superficialia,stromatibus parvis partim superficialibus partim in substrato in mersisoriunda, ex stipite brunneo et massam candidam, conidiorum composita. Stipes conidiophoris numerosis dense fasciculatis, agglutinatis compositus in primis ca 10 µm usque 50 µm long, annulis 1-3 fuscioribus rugosis, massam subglobosam, plerumque ca. 150 x 100 µ m, conidiorum et cellularum sterilium aristiformium. Microaristae irregulatim sigmoideae velfalcatae plerumque torsivae, hyalinae, 25-30 µm (27,5 µm) long, 3-3,5 µm lat. Medio, utrinque angustatae, cum parte destali parietem crassiusculum habenti, verruculosa, cum parte proximali tenui et laevi. Conidiophora septata ramosa, compacta et connata, flavo-brunnea, usque 100 µm long, 1,5-2 µ m lat, phialides terminales, pallidiorus 15-25 x 1,5-3 µm, apice minutum collum ferentis. Conidia lunata vel naviculiformia, apice angustato, base truncata, hyalina, laevia, guttulata 13,5-15 x 2,5-2,7 µm, utrinque solo filiformi, tubulari 10-13 µm long appendice praedita.

Holotypus in foliis putridis Scutia buxifolia, Pta Indio. Magdalena, Prov. Buenos Aires, Argentina. April 2001. LPS 47406.

Synnemata scattered, superficial, arising from small, partly superficial, partly immersed stromatic aggregations of hyphal cells, composed of amore or less elongated, brown stalk bearing a white mass of conidia. Stalk composed of several hundred conidiophores which are closely packed and partly fused together, at first about 10 µm long, forming a flat area with the conidiogenous cells, then up to 50 µm long, ringed by up to three brown transverse ridges or articulations each representing an area of synchronous proliferation of all conidiophores, topped by a subglobose mass, mostly about 150 x 100 µm composed of liberated conidia and microawns. *Microawns* produced from conidiogenous cells and liberated with the conidia, irregularly sigmoid, twisted in two planes, hyaline 25-30 µm (27,5 µm) long, 3-3,5 µm wide tapering at each end, distal half thick-walled, sparse by verruculose, proximal half thin-walled. *Conidiophores* septate, branched proliferating at intervals, pale brown, up to 100 µm long. *Conidiogenous cells* phialidic, cylindrical, each 15-25 x 1,5-3 µm and bearing a single minute collaret at

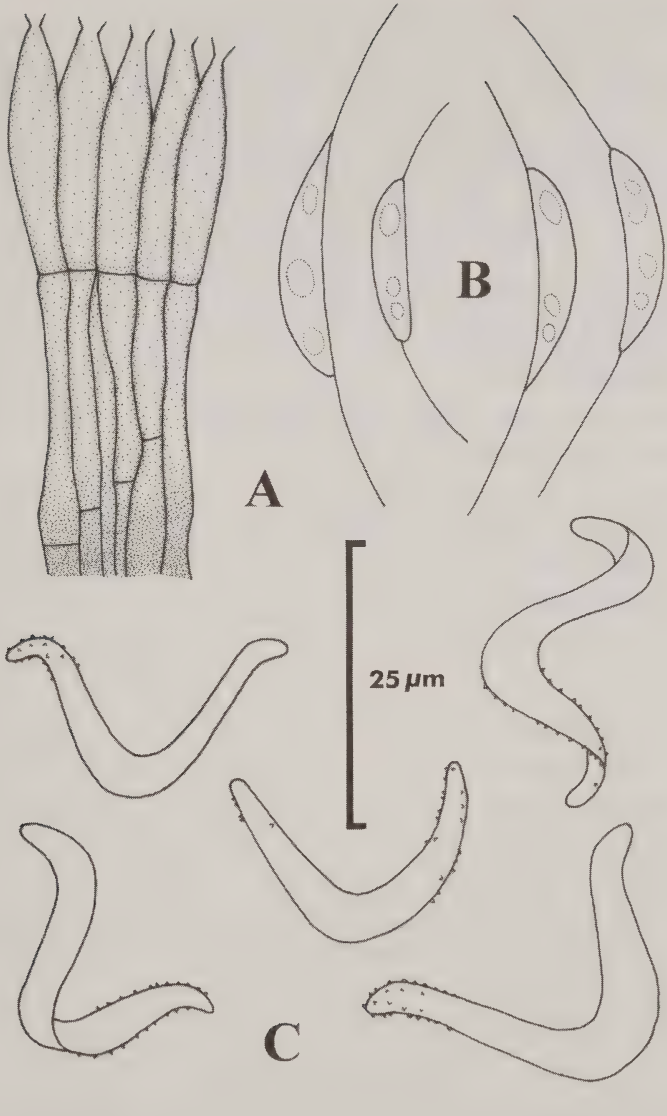

Fig.1. A. Detail of conidiogenous cells, B. Conidium, C. Detail of microawns

the open apex. Conidia hyaline, lunate or naviculate, narrowed at the apex, narrow and truncate at the base, unicellular smooth-walled and guttulate, 13,5–15 x 2,5–2,7 μm provided at each end with a single, filiform appendage 10-13 μm long.

Specimen examined: on leaf litter of *Scutia buxifolia*

T. buxifolia has a close affinity with *T. havanensis* Castañeda and *T. cristata* Pirozynski & Hodges. In *T. havanensis* the synnema is sessile or nearly so and the conidia have both ends fusiform, in *T. buxifolia* the stiped synnema grows with age of the conidiomata and has a ring of proliferating conidiophores as happens in *T. cristata* but differs in the shape and size of the microawns that in *T. cristata* are 40-60 μm long and thick-walled and in *T. buxifolia* many reach 30 μm long, and are sigmoid and thin-walled.

Key to the species of *Thozetella*

A. With microawns produced in different ways,	
B. Conidiomata sporodochial	
C. Conidiophores compact	
D. Microawns L-shaped with the basal arm thin-walled.	***T. nivea***
D.' Microawns of different forms	
E. Microawns sigmoid and uncinate smooth	***T. cubensis***
E.' Microawns sickle-shaped or irregularly sigmoid, verruculose on one surface	***T. canadensis***
C'. Conidiophores effuse	***T. effuse***
B'. Conidiomata synnematal	
F. Synnema radicant	
G. Microawns smooth	***T. radicata***
G'. Microawns verruculose	***T. tocklainensis***
F'. Synnema not radicant	
H. Microawns smooth	***T. cristata***
H'. Microawns verruculose	
I. Microawns and conidia in a mucoid mass	***T. havanensis***
I'. Microawns and conidia not forming a mucoid mass	***T. buxifolia***
A'. Without microawns.	***T. ciliata***

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MYCOTAXON

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NATS truffle and truffle-like fungi 10: *Pachyphloeus thysellii* sp. nov. (*Pezizaceae*, Pezizomycotina)

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Abstract—An undescribed truffle found on the Fort Lewis Military Reservation near Olympia, Washington, is described as *Pachyphloeus thysellii.* This new species, associated with *Pseudotsuga menziesii,* closely resembles *Pachyphloeus prieguensis* from southern Europe. It differs from the latter in having yellow veins and patches showing among the minute, brown warts on the peridial surface, smaller asci, and a different mycorrhizal host.

Introduction

Integrated research on ecosystem functions in forests of 55 to 65-yr-old *Pseudotsuga menziesii* (Mirb.) Franco at Fort Lewis Military Reservation near Olympia, Washington includes studies of the small mammals that feed on fungi. As hypogeous fungi are a major food base for the small mammals, standing crops of those fungi were monitored at 6-week intervals for nearly 3 years (Colgan et al., 1999). During this time, the genus *Pachyphloeus* was represented by one undescribed species, for which we propose the name *Pachyphloeus thysellii.*

Methods

At each collecting time, 10 plots of $4m^2$ each were raked into mineral soil along each of 16 transects. All specimens found in plots were collected, identified and dried for estimation of standing crops and for herbarium deposit (Colgan et al., 1999). Colors of fresh specimens are in general terms of the author. Specimens were dried with a forced air dehydrator at 49°C (120°F). Microscopic characters were determined from hand sections mounted in 5% KOH, Melzer's reagent, or cotton blue, as indicated. Spore dimensions are based on at least 50 randomly selected spores and do not include ornamentation. Light photomicrographs are from sections mounted in 5% KOH unless otherwise indicated. For electron microscopy, dried spores were mounted on pegs with double sided tape, coated with gold and examined with an Amray 3000 scanning electron microscope. The holotype and paratypes have been accessioned into the Mycological Herbarium of Oregon State University (OSC).

Taxonomy

Pachyphloeus thysellii sp. nov.

FIGURE 1

Species haec ab Pachyphloeus prieguensis, P. melanoxanthus *et* P. virescens *ob peridio verrucoso-reticulato, brunneo vel fulvo, venis et maculis luteis, et ascis ellipsoideis vel subglobosis. Holotypus hic designatus: OSC 80960.*

Etymology: "*thysellii*" in honor of the collector of the type specimen, David Thysell, a research botanist with the USDA Forest Service and cooperator on the Forest Ecosystem Project at Fort Lewis

Ascomata subglobose to irregular, 0.8-2 cm in diameter, minutely warty, brown to tawny with yellow veins and patches showing among the warts; texture rubbery, odor mild to slightly onion like, taste not recorded, hard when dried. **Gleba** off-white to yellowish translucent, with white and yellowish alternating veins radiating from a central cavity containing cottony hyphae.

Excipulum (peridium) 200-300 μm thick, with two layers: **ectal excipulum** 150-250 μm thick, brown to pale yellow, compactly arranged, of inflated, brown-walled polygonal cells 35-45 μm broad, the walls ca. 1μm thick; ental **excipulum** 40-60 μm thick, hyaline, of tightly interwoven hyphae 6-8 μm broad, with many cells inflated up to 10 μm, the walls ca. 1μm thick. **Medullary excipulum** (gleba) of hyaline, interwoven, branched hyphae 6-10μm in diam. **Asci** 8-spored, elliptical to reniform or subglobose, 80-110 x 40-60 μm including a short to prominent stem 10-60 x 8-15 μm, hyaline, the walls 1 μm thick, not amyloid, weakly cyanophilic in cotton blue, the spores biseriate or clustered in the asci.

Spores predominantly globose, 12-17 μm broad excluding ornamentation, the walls ± 1 μm thick and hyaline in KOH and Melzer□s reagent but strongly cyanophilic in cotton blue. **Ornamentation** of symmetrical rods ≥2 x 0.7-1 μm tall, cyanophilic; spore wall ±1 μm thick. **Episporium** hyaline, inconspicuous, adherent to the tips of the ornamentation.

Habit, habitat and season – Hypogeous; at 400 ft elevation in 55-65-yr.-old thinned stands of *Pseudotsuga menziesii* (Mirb.) Franco on glacial till, August.

Collection examined – HOLOTYPE here designated: Washington, Thurston Co. Fort Lewis Military Reservation, Hill block, stand 3, in root-rot treatment area, below an excavated wasp nest, Col. D. Thysell. 24 Aug. 1994 (OSC 80960). **PARATYPE:** Washington, Thurston Co. Fort Lewis Military Reservation, Stellar block, stand 1, heavily thinned treatment, Col. Wes Colgan III, 18 Aug. 1993 (OSC 80959)

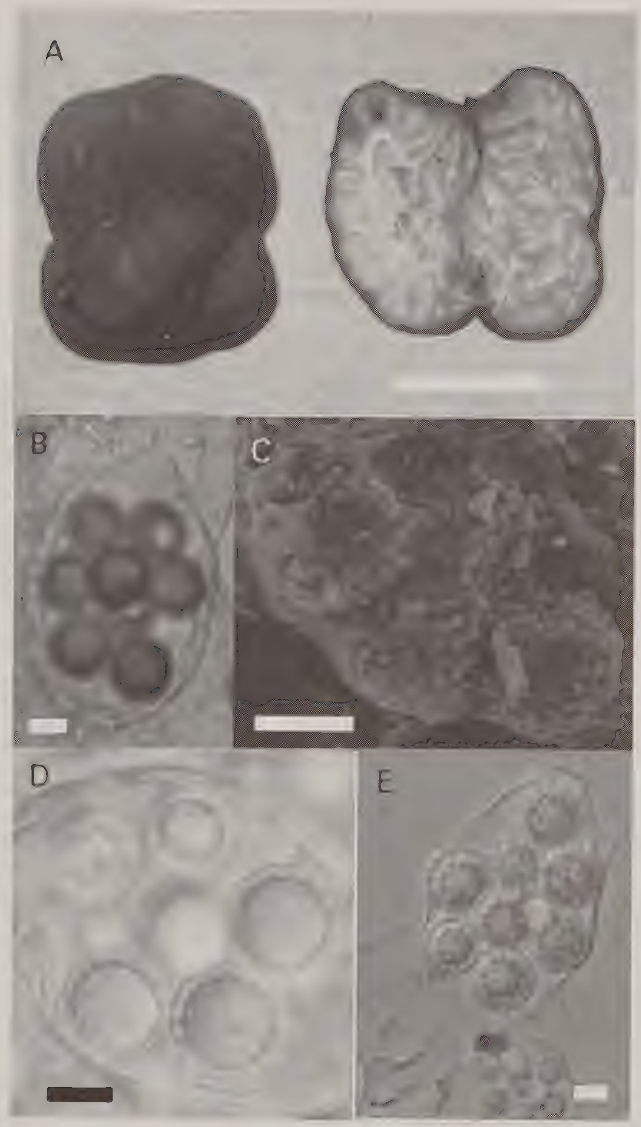

Fig. 1. *Pachyphloeus thysellii*. A. Sporocarp shown in cross-section showing external surface (left) and gleba (right). Scale bar 1cm (OSC 80960). B. Light micrograph of spores and ascus stained with cotton blue. Scale bar 10μm (OSC 80959). C. Scanning electron micrograph of spores. Scale bar 10μm (OSC 80959). D & E. Light micrographs (Nomarski optics) of spores and asci Scale bar 10μm (D, OSC 80960; E, OSC 80959).

Discussion

Pachyphloeus thysellii is closest to *P. prieguensis* Moreno-Arroyo, J. Gomez & Calonge from southern Europe. That species, however, lacks the yellow veins and patches between the peridial warts, has larger asci, is associated with deciduous trees and occurs in calcareous soils. *P. virescens* Gilkey differs in peridial coloration and structure. *P. thysellii* possesses darkly pigmented angular warts similar to *P. melanoxanthus* (Tul.) Tul. & C. Tul, but the space between the peridial warts is brown rather than yellow and it is associated with deciduous trees.

Acknowledgments

This research was conducted under grants, contracts, and agreements to Andrew B. Carey, Leader, Ecological Foundations of Biodiversity Team, from the USDA Forest Service. Specifically, funding was provided by the U.S. Army, Fort Lewis Military Reservation, the USDA National Research Initiative Competitive Grants Program (Grant No. 9401095) and the USDA Forest Service, Pacific Northwest Research Station.

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Lactarius in Kumaon Himalaya 3: A new species of subgenus *Lactifluus*

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Abstract—An undescribed *Lactarius* species in subgenus *Lactifluus* has been found in Kumaon, Himalaya. The combination of features with regard to basidiome and latex color, basidiospore form, and thick walled hymenial cystidioid elements distinguish this new species, *L. capitatus*, from its close relative, *Lactarius luteolus* of U.S.A. The basidiomes of the species described here were found growing under *Quercus leucotrichophora* in subtropical deciduous forests.

Key words—macrofungi, *Russulaceae*, taxonomy, India, ectomycorrhizal fungi

Introduction

Critical examination of specimens of *Lactarius* has been carried out in Kumaon, Himalaya. The gathered information allows us to confirm the presence of members of subgenus *Lactifluus* in this Indian region. From the eight taxa of subgenus *Lactifluus* (Burl.) Hesler & A.H. Sm. currently known in India (Das & Sharma 2002), six species including *Lactarius capitatus* described in this communication have been collected from this area.

Materials and Methods

The present communication is based on fieldwork in Kumaon, Himalaya, undertaken periodically during last five years, by two of us (KD & JRS). Macroscopic characters were recorded in fresh specimens. Microscopic study was carried out on dry samples, mounting hand sections of basidiomes in 5% KOH, Melzer's solution, Congo red, Lactophenol-cotton blue and carbol fuchsin. Color terms mentioned follow Kelly & Judd (1955). All line drawings were made by K. Das. Microscopic line drawings were prepared with the aid of a camera lucida at original magnification of 1500x for basidiospores, 1000x for cystidia and basidia, 500x for other microstructures. Density of lamellae (= L/cm) was measured at pileus attachment excluding lamellulae. Basidiospore length excludes the ornamentation height. Basidium length excludes the sterigmata length. Width of the elements of suprapellis was measured at their apices. For basidiospore dimensions the range observed in the collections is reported based on 25 basidiospores per collection. **RM** corresponds to the range of means of length and width of the collections. **Q** is the range of mean values of coef. Q (length/width ratio of spores). Herbaria housing the cited specimens are abbreviated after Holmgren et al. (1990). Scanning electron microscope (SEM) study was made by L. Montoya following Montoya & Bandala (2003).

Description of the species

Lactarius capitatus K. Das, J.R. Sharma & Montoya *sp. nov.*

Figure 1a-g; 2a-d.

Etymology: After the characteristic capitate microstructures.

Pileus 50–80 mm diam, planoconvexus, siccus leviter depressus in centro, ferrugineus, brunneoaurantiacus, griseoaurantiacus vel griseorufus, margine saepe cinnabarinus, incurvo. Lamellae subdecurrentes, subdistantes, pallide aurantiacus. Stipes 33–63 x 10–18 mm, cylindratus, pileo concolorus. Latex translucido-albus, albo ad griseo-luteo, pallidus griseo-rubescens vel brunnescens. Contextus aurantiacus, brunnescens. Odore piscis similis. Sporae in cumulo albae, (6.4-) 7–8.8 (-9.6) x (5.6-) 6.4–7.8 (-8) µm, globosae vel subglobosae, amyloideae, verrucosae. Pseudocystidia abundantia, cylindrica. Cellulae ad lamellae margine 33–70 x 4.6–7.5 µm, abundantia, capitata, septata. Pileipellis trichodermis, bistrata; elementa suprapellis 20–135 x 5.5–13 µm, capitata et subcapitata; subpellis pseudoparenchymata. INDIA, Uttaranchal, Bageshwar, Loharkhet top, September 15, 2003, leg. K. Das & J.R. Sharma, KD7001 (HOLOTYPUS, BSD; ISOTYPUS, XAL).

Pileus 50–80 mm diam, planoconvex to slightly depressed when mature; pileipellis dry, matted pruinose to velvety, sometimes minutely areolate towards center at maturity, medium reddish to grayish-orange, grayish-red, medium to brownish-orange, often dark red at the edge; margin incurved to decurved, wavy, often crenate. **Lamellae** decurrent, close at first sight but subdistant when excluding the lamellulae (ca 5–6 per cm), light orange to orange-yellow, light to medium reddish-brown after bruising; lamellulae in five different lengths. **Stipe** 33–63 x 10–18 mm, dry, matted, cylindric or slightly tapered towards base, often longitudinally grooved, dry, matted, concolorous to pileus. **Context** solid, pale to light orange-yellow or ochraceous, turning slowly brownish. **Latex** at first whey like, later white to pale buff, droplets turning very slowly to pinkish, finally dark reddish-brown to brown, staining the white paper medium brown. **Odor** spicy to fishy. **Spore print** white.

Basidiospores (6.4-) 7–8.8 (-9.6) x (5.6-) 6.4–7.8 (-8) μm, RM = 7.8–8.3 x 7–7.2 μm, Q = 1.03–1.11, globose to subglobose, ornamentation amyloid, 0.6-0.8 μm high, composed mostly of conical isolated warts, at times connected or somewhat aligned; under SEM the ornamentation appears as subcylindric warts, broadened towards base, apex rounded, isolated or aligned and even interconnected at base level,

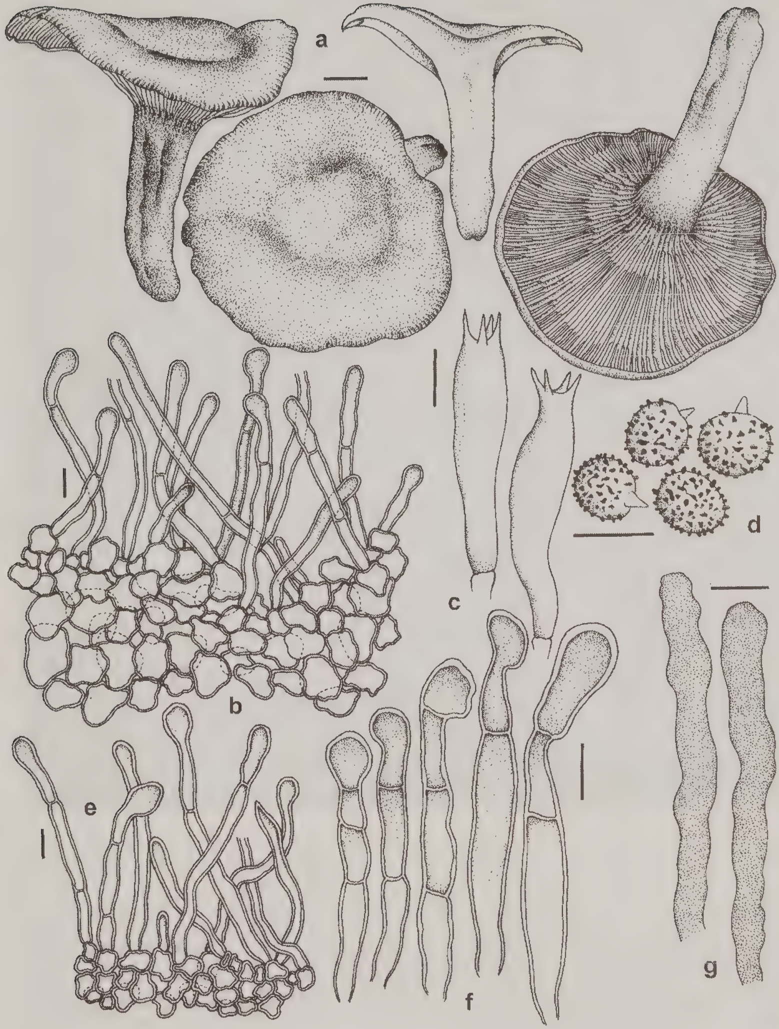

Fig. 1. *Lactarius capitatus* (from holotype). a. Basidiomes. b. Cross-section of pileipellis. c. Basidia. d. Basidiospores. e. Cross-section of stipitipellis. f. Marginal cystidioid elements. g. Pseudocystidia. Bars: a = 10mm; b–g = 10 μm.

at times with rounded, sinuous or truncate ridges; with suprahylar plage. Basidia 34–44 x 8–10 *µ*m, subclavate to clavate, 4-spored; sterigma up to 7.5 *µ*m long. Hymenial cystidioid elements abundant, subcylindric, capitate, septate, wall 0.8-1.6 µm thick, with hyaline or slightly yellowish and dense contents; at lamellae surfaces 38.4-92 x 5.6-8 *µ*m, terminal segments 12-24 x 5.6-8.8 *µ*m; at lamellae margins 33–70 x 4.6–7.5 *µ*m, abundant, often septate, terminal segments 14.4-28 x 4.8-8.8 *µ*m. Pseudocystidia abundant, subcylindric, 4-6.4 *µ*m broad. Pileipellis a trichodermis of two layers, up to 225 *µ*m thick; elements of suprapellis 20–135 x 5.5–13 *µ*m, filamentous, capitate or subcapitate to cylindric, mostly hyaline or with dense yellowish contents, often septate, wall 0.8-1.6 *µ*m thick; subpellis pseudoparenchymatous; cells 7–34 x 6–24 *µ*m, wall 0.8-1.6 (-2.4) *µ*m thick. Hymenophoral trama mostly cellular, sphaerocytes 8-28 *µ*m diam, hyphae 4-4.8 µm thick, laticifers 8-11.2 µm diam, subhymenium thick and cellular Stipitipellis two layered; elements of suprapellis 18–125 x 4–12 *µ*m, capitate or subcapitate to fusiform, often septate, thick walled; wall up to 1 *µ*m broad; subpellis pseudoparenchymatous of subisodiametric cells, 10–20 x 6–14 *µ*m.

Ecology — *Lactarius capitatus* is a rare species forming ectomycorrhizal association with *Quercus leucotrichophora* A. Camus in subtropical to temperate (1900–2200 m) deciduous forests in Kumaon Himalaya.

SPECIMENS EXAMINED -- **INDIA**, **UTTARANCHAL**: **Bageshwar**, LOHARKHET TOP, 15.IX.2003, leg. K. Das & J.R. Sharma, KD7001 (**HOLOTYPE**, BSD; isotype XAL); *ibid.*, 15.IX.2003, leg. K. Das & J.R. Sharma, KD7004 (BSD); *ibid.*, 26.IX.1999, leg. K.Das & J.R. Sharma KD1095 (BSD).

ADDITIONAL SPECIMENS EXAMINED -- *Lactarius luteolus* Peck. **UNITED STATES**. **MASSACHUSSETTS**, **East Milton**, August, H. Webster *s/n* (**HOLOTYPE**, NYS).

Comments — *Lactarius capitatus* is distinguished in the field by having the pileus and stipe surfaces matted, pruinose to velvety, reddish to brownish-orange, the lamellae and context are pale to light orange-yellow or ochraceous, latex droplets turning slowly to pink and finally dark reddish-brown to brown, and mild spicy odor in the fresh material. Moreover, the verrucose basidiospores and presence of typical capitate to subcapitate thick walled cystidioid elements in the hymenium and suprapellis of both pileus and stipe make the species very distinct.

Lactarius capitatus is closely related to *L. luteolus*. The latter differs in that the basidiomes lack reddish tinges [being buff, white or whitish-buff (Peck 1896, Hesler & Smith 1979)]. Moreover, *L. luteolus* presents white latex droplets staining brown, and as observed in the holotype it has elliptic basidiospores (Q = 1.3) and thin walled or slightly thick walled (0.8 µm thick) marginal cystidioid elements.

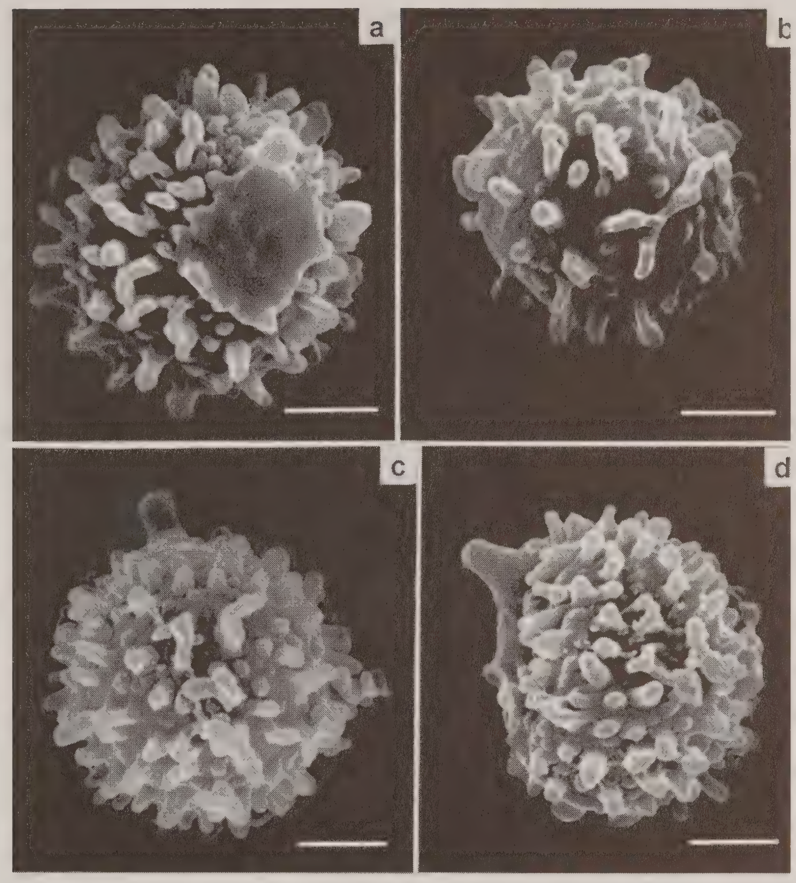

Fig. 2. Scanning Electron Micrographs of basidiospores of *Lactarius capitatus* (from holotype). a–b. X 8500. c–d. X 8000. Bars = 2 μm.

Lactarius nonpiscis Verbeken shares with the present taxon capitate, septate and thick walled elements of the suprapellis, stipitipellis and hymenial marginal cells, as well as verrucose basidiospores (Verbeken et al. 2000). However, *L. nonpiscis* differs by having smaller basidiomata [pileus 13–26 mm diam, stipe 20-40 x 3-7 (-10) mm], strongly wrinkled pileipellis with small veins, more ellipsoid basidiospores (Q = 1.31-1.36) and higher basidiospore ornamentation (up to 1.5 μm) (Verbeken et al. 2000).

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MYCOTAXON

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Four new records in the genus *Albatrellus* (*Aphyllophorales, Albatrellaceae*) from China

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Abstract—*Albatrellus citrinus*, *A. flettii*, *A. skamanius* and *A. tianschanicus* are newly reported from China. Line drawings depict the microscopic characters of the four species.

Key words—diagnostic characters, distribution

Introduction

Thirteen species of the genus *Albatrellus* have been recorded from China (Bi, Zheng & Li 1994, Mao 1998, Zhang 1999, Zhao & Zhang 1991, Zhao 1998, Zheng 1992). In recent years, during the course of our studies on the genus *Albatrellus* from southwestern China, ninety-eight specimens were examined. Twelve species were identified. Among them, *Albatrellus citrinus* Ryman, *A. flettii* Morse ex Pouz., *A. skamanius* (Murr.) Pouz. and *A. tianschanicus* (Bondartsev) Pouz. are new to China. Differences between similar species are provided and discussed.

Materials and Methods

The descriptions appear in alphabetical order by species name. Features of fresh basidiomes were taken from field notes with the specimens.

Microscopic examination of basidiomes and measurements of microscopic structures were made from freehand sections mounted in 5% KOH, 1% congo red and Melzer's reagent.

All specimens examined are preserved in the Cryptogamic Herbarium, Kunming Institute of Botany, Academia Sinica (HKAS).

**Corresponding author*

Descriptions of the Species

Albatrellus citrinus **Ryman**, Mycol. Res. **107** (10): 1243-1246, 2003

Fig. 1: a-d

SPECIMEN EXAMINED — CHINA, TIBET: Ri Dong, under *Picea*, alt. 3200 m. 13. Sept. 1982, Zang 984 (HKAS 10748).

REMARKS: The characters of the specimen cited above agree closely with the original description. This is especially true of the macroscopic characters and habitat. According to the macroscopic characters, the specimen has small scales in the center of the pileal surface, not so smooth as described in the original description. Other characters are identical with the holotype. The basidiomes of the holotype grew solitary or more often clustered in large rings, amongst mosses in herb-rich spruce forest on calcareous soil (Ryman et al. 2003). The Chinese specimen was also collected under *Picea*.

The microscopic characters of this species were not given in detail in the original description, simply stated as “hyphal system monomitic, without clamp connections,” and gave the size of the basidiospores. More detailed microscopic characters drawn from the specimen cited above are provided to give more information about this species.

Hyphal system monomitic. Generative hyphae without clamp connections. Contextual hyphae hyaline, mostly 7.0-15.0 μm in diameter, some inflated up to 30 μm, branching, thick-walled, the walls up to 1.5 μm thick (Fig.1-d). Tramal hyphae are more uniform, 3.0-6.0 μm in diameter, thin-walled (Fig.1-c). Pileipellis hyphae repent or some erupt, cylindrical.

Cystidia none. Basidia clavate, 24.0-30.0 × 8.5-10.0 μm, 4-sterigmate, each 2.0-3.0 μm long, simple-septate at the base. Basidiospores distinctly amyloid, broadly ellipsoid, measured 4.5-5.5 × 3.0-4.5 μm (Fig.1-a), which are slightly larger than that of the holotype (4-4.5 × 3-4 μm). This slight difference does not warrant a specific or varietal distinction.

There are two species similar to *A. citrunus*. One is *A. subrubescens*, due to the coloration of the basidiomes, generative hyphae lack clamp connections and amy- loid basidiospores of similar size. However, it can be distinguished from *A. citrinus* in the normally larger basidiomes, the pileus turning orange, not yellow on handling, and growing with *Pinu*s on poor sandy soil. Another is *A. ovinus*, morphologically similar to the species in that it also grows in connection with *Picea* and has basidiomes turning yellow with age or when handled. But *A. ovinus* has much larger basidiomes, the yellow colors of the pileus usually have a green tint, the fresh basidiomes never turning orange when dried, and the basidiospores are inamyloid. *A. citrinus* and *A. ovinus* seem to be more closely related than to *A. subrubescens* according to the result of molecular data (Ryman et al. 2003).

This species has previously only been reported from Sweden (Ryman et al. 2003) and is new to China.

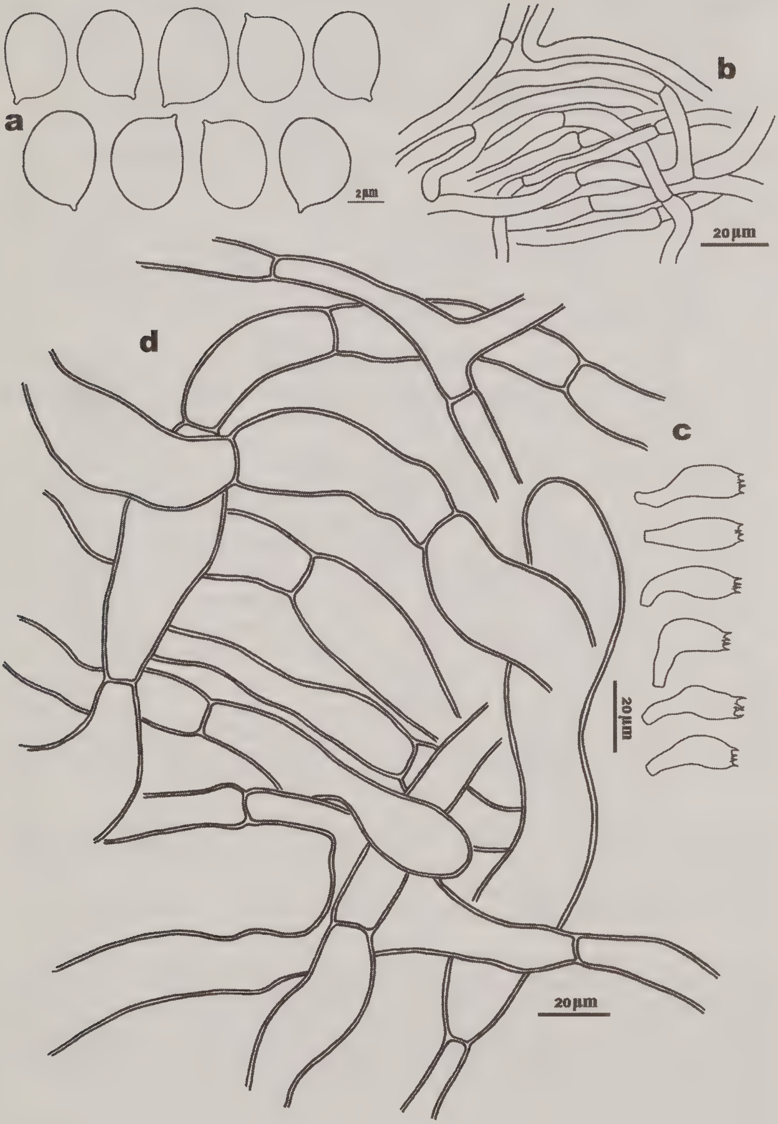
a
2μm
b
20μm
d
c
20μm
20μm

Fig.1 *Albatrellus citrinus* Ryman (HKAS 10748)
a. basidiospores b. tramal hyphae c. basidia d. contextual hyphae

Albatrellus flettii **Morse ex Pouz.,** Česká Mykol. **26**: 198, 1972
Polyporus flettii Morse, Mycologia **33**: 507, 1941 (invalid name, no Latin diagnosis)

Fig. 2: a-d

SPECIMEN EXAMINED — CHINA, YUNNAN PROV.: Nanhua Co. town wild mushroom market. 26. Aug. 2002. Zheng Huan-Di 128 (HKAS 21574).

REMARKS: The Chinese specimen matches closely the original description and other accounts of *A. flettii* (Morse 1941, Pouzar 1972, Gilbertson & Ryvarden 1986, Ginns 1997). However, the pileus of the specimen is only 9 cm in diameter, which is smaller than that of the North American specimens (up to 20 cm). In addition, some characters of the species drawn from the Chinese specimen were not mentioned in the previous articles (Morse 1941, Pouzar 1972, Gilbertson & Ryvarden 1986, Ginns 1997). They are described as following.

The blue tints of the pileus surface becoming deeper when touched or scraped, with some light brick red splotches after kept in herbarium for some time. The pore surface is cream colored, slowly becoming blue when bruised and brownish on drying.

The species is microscopically similar to *A. confluens* (Alb. & Schw. : Fr.) Kotl. & Pouz. in hyphal characters and basidiospore morphology. They are different in the color of the pileal surface. *A. flettii* is blue-green, whereas *A. confluens* is totally orangish buff to pinkish buff. The coloration variation of different basidiomes of *A. flettii* in all sizes and ages had been described in detail (Ginns 1997). It is impossible to distinguish both species on basis of their microscopic characters without knowing their colors in fresh condition. There was a peculiar character occurring in both species, which called acanthopendia, are cylindrical appendages on the mycelial hyphae covering the stipe base. They are ornamented with hollow, conical spines, being very similar to the acanthophyses of some resupinate and similar fungi (Pouzar 1972). This structure was not mentioned in other articles and was not observed in the Chinese specimen. The rare morphological differences between basidiomes of *A. flettii* and *A. confluens* indicate that they are sister species and may be subspecies (Ginns 1997).

Another *Albatrellus* species with bluish pileal surface is *A. caeruleoporus* (Pk.) Pouz. However, its pileus and pores are entirely blue-gray and the generative hyphae are simply septate, whereas *A. flettii* has blue-green pileal surface but whitish pores and the generative hyphae have clamp connections.

This species had been collected under mixed forest (Morse 1941) and typically with *Tsuga*, other conifer genera and hardwood genera also present in the vicinity of it (Kropp & Trappe 1982, Ginns 1997, Gawin 1998). The specimen cited above was encountered in the market of Yunnan, so the habitat data is unknown. The species is widely distributed in USA (Gilbertson & Ryvarden 1986, Ginns 1997) and is new to China.

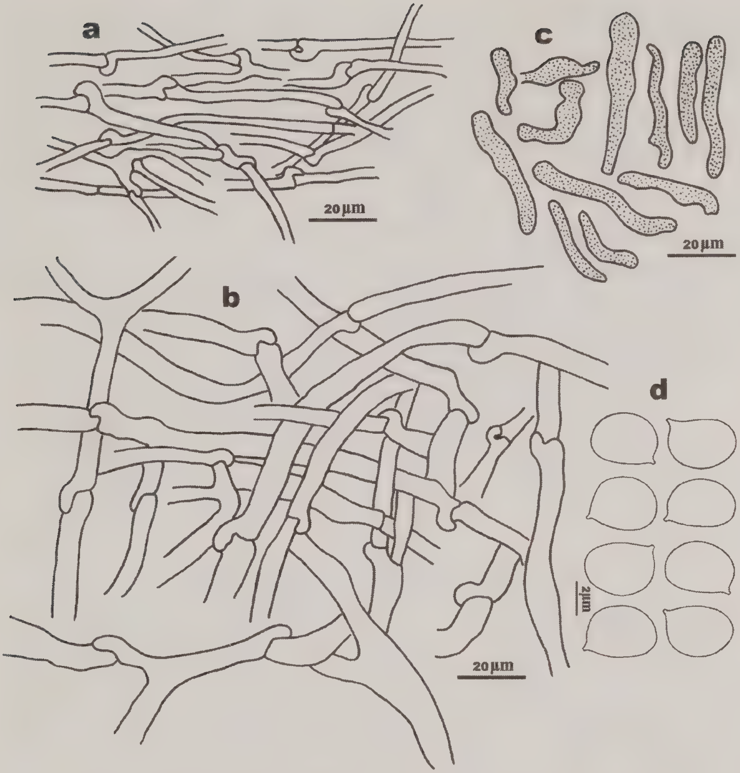

Fig.2 *Albatrellus flettii* Morse ex Pouz. (HKAS 21574)
a. tramal hyphae b. contextual hyphae c. gloeoplerous hyphae d. basidiospores

Albatrellus skamanius **(Murr.) Pouz.**, Česká Mykol. **26**: 199, 1972
Polyporus skamanius **Murr.**, Mycologia **38**: 348, 1946

Fig.3: a-d

SPECIMEN EXAMINED — CHINA, YUNNAN PROV.: Nanhua Co. town wild mushroom market. 9. Sept. 2000. Wang Xiang-Hua1156 (HKAS 37109).

REMARKS: The specimen cited above has glabrous to aerolate, blackish pileus, whitish pores and context, generative hyphae with clamp connections and large basidiospores. These are the diagnostic characters of *A. skamanius*. However, there are a few differences between specimens from China and North America. The tubes of the Chinese specimen are discoloring cream or light brownish when bruised, not bruising gray, and the context is not discoloring when cracked or injured as indicated in the description of North American specimens (Ginns 1997). In addition, it was reported that the gloeoplerous hyphae are frequent in context and trama (Gilbertson & Ryvarden 1986, Ginns 1997), but they were rarely seen in our specimen. Probably they are variable because of

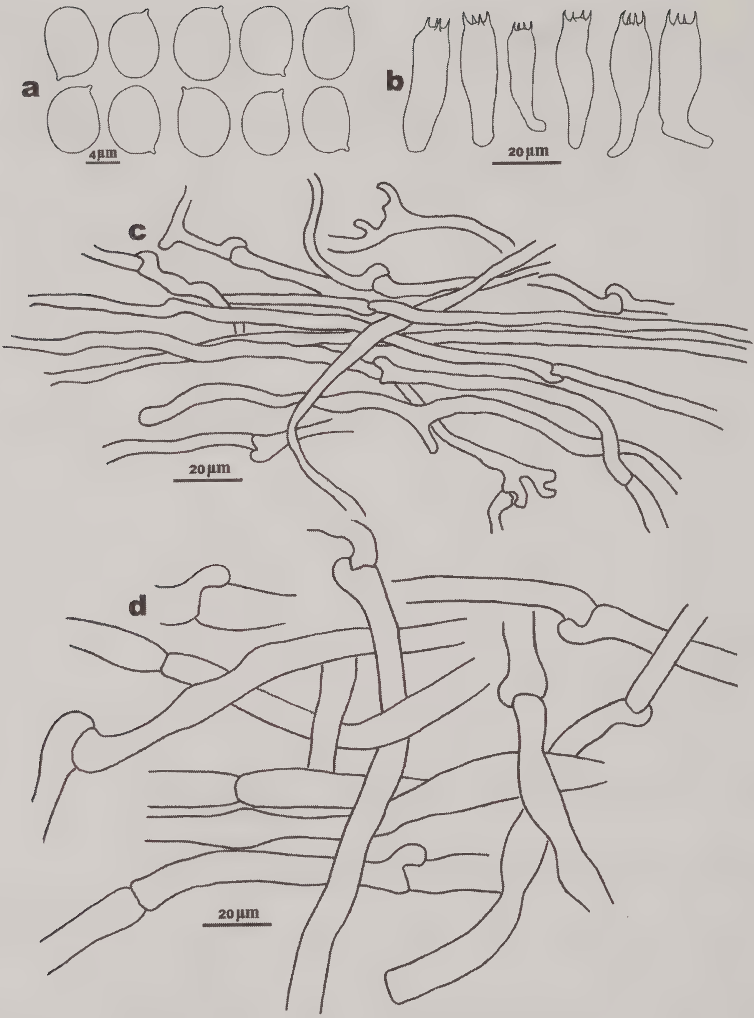

Fig.3 *Albatrellus skamanius* (Murr.) Pouz. (HKAS 37109)
a. basidiospores b. basidia c. tramal hyphae d. contextual hyphae

different environments and development stage of basidiomes.

The two other *Albatrellus* species with large pores, clamp connections, and relatively larger basidiospores are *A. ellisii* (Berk.) Pouz. and *A. pes-caprae* (Pers. : Fr.) Pouz.. *A. ellisii* is distinguished by its olivaceous yellow, yellowish to yellowish tan pileus, becoming grass greenish on handling, and covered by a layer of thick and coarsely scales composed of erect hyphae. *A. pes-caprae* is distinguished by its brownish to reddish brown color of the pileus and the fibrillose scales covering the pileus surface. In addition, the basidiospores of *A. skamanius* are slightly smaller than those of *A. ellisii and A. pes-caprae* (Gilbertson & Ryvarden 1986, Ginns 1997).

This species is collected under conifers, maybe fir or *Tsuga* (Murrill 1946, Gilbertson & Ryvarden 1986, Ginns 1997). It occurs in northwestern USA (Gilbertson & Ryvarden 1986, Ginns 1997, Pouz. 1972) and is new to China.

***Albatrellus tianschanicus* (Bondartsev) Pouzar**, Folia Geobot. Phytotax. Bohem. **1**: 358, 1966
***Scutiger tianschanicus* Bondartsev**, Bot. Mater. Otdel. Spor. Rastenij. **13**: 220-221, 1930

Fig.4: a-d

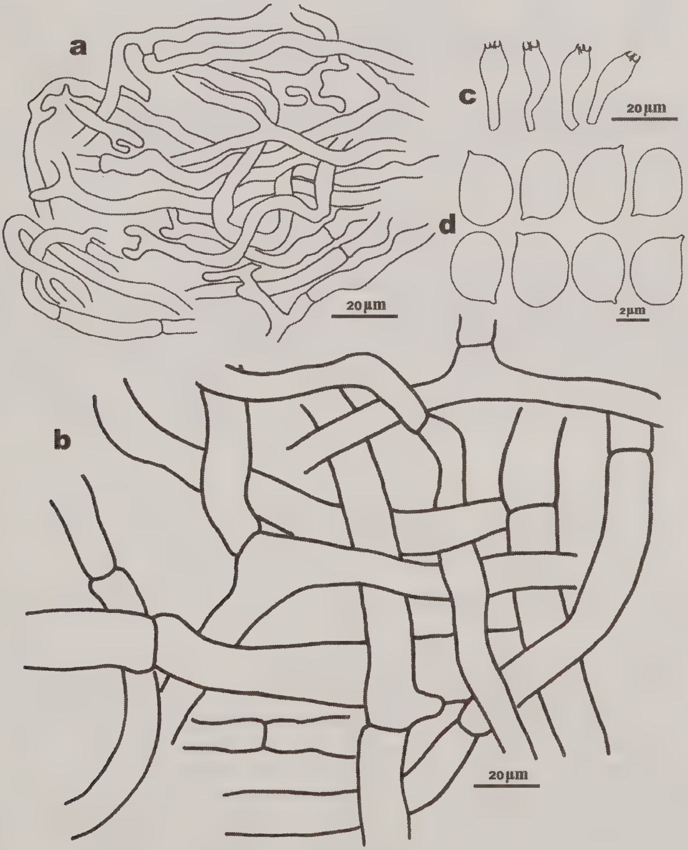

Fig.4 *Albatrellus tianschanicus* (Bondartsev) Pouzar (HKAS 23855)
a. tramal hyphae b. contextual hyphae c. basidia d. basidiospores

SPECIMEN EXAMINED — CHINA, SICHUAN PROV.: Hongyuan. 23. Aug. 1991. Yuan Ming-Sheng1695 (HKAS 23855).

REMARKS: The squamulose pileal surface, the apricot coloration, the light orange stipe with a black base, and generative hyphae lacking clamp connections are conspicuous characters which can be used to distinguish *A. tianschanicus* from other *Albatrellus* species. The specimen cited above is in close agreement with the diagnostic characters mentioned above. It is reported that basidiomes are centrally stipitate (Núñez & Ryvarden 2001, Ryvarden & Gilbertson 1993), however, the stipe of the Chinese specimen is slightly eccentric. The basidiospores of Chinese specimen measured 3.5-5.0 × 2.5-4.0 μm, which has a wider range than that of Russian collections (measured 4.5-5.5 × 3-4 μm, Ryvarden & Gilbertson 1993, Núñez & Ryvarden 2001).

The species is close to *A. cantharellus* (Lloyd) Pouz. because both lack clamp connections and have amyloid basidiospores. It differs in its smaller basidiospores (measured 5-7 × 4.5-5.5 μm in *A. cantharellus*) and light orange stipe with a black base which is white in *A. cantharellus* (Núñez & Ryvarden 2001).

This species is reported on the ground under *Picea* (Ryvarden & Gilbertson 1993, Núñez & Ryvarden 2001). It occurs in central Russia (Ryvarden & Gilbertson 1993, Núñez & Ryvarden 2001) and is new to China.

Acknowledgements

The authors would like to thank Prof. Leif Ryvarden, Division of Botany and Plant Physiology, Department of Biology, University of Oslo, Norway and Dr. James H. Ginns, ECORC, Agriculture and Agri-Food Canada for their critical reviews, and for their invaluable comments and suggestions on this manuscript. The study was supported in part by grant from the National Science Foundation of China (No.30070004) and the Knowledge Innovation Program of the Chinese Academy of Sciences (project grant no. KSCXZ-1-09-06 & KSCXZ-SW-101C).

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地花菌属的四个中国新记录种

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摘要：本文报道了地花菌属的四个中国新记录种。柠檬黄地花菌(*Albatrellus citrinus* Ryman)菌盖表面黄白色，子实层白色，干后子实体变为橙色，生殖菌丝没有锁状联合，担孢子4.5-5.5 × 3.0-4.5 µm，淀粉质，生于云杉(*Picea*)林下。蓝黄地花菌(*A. flettii* Morse ex Pouz.)菌盖表面幼时蓝色，蓝色会随着生长慢慢消褪，子实层白色，生殖菌丝具锁状联合，担孢子较小，4.5-5.5 × 3.0-4.5 µm。黑色地花菌[*A. skamanius* (Murr.) Pouz.]菌盖表面为黑色，龟裂成许多小块状的鳞片，子实层白色，生殖菌丝具锁状联合，孢子大，7.0-9.0 × 5.5-6.5 µm。天山地花菌[*A. tianschanicus* (Bondartsev) Pouz.]子实体杏黄色或淡橙色，菌盖表面具小鳞片，菌柄上部杏黄色，基部渐细且为黑色，生殖菌丝没有锁状联合，担孢子3.5-5.0 × 2.5-4.0 µm，淀粉质。

关键词：地花菌属，新记录种，中国

MYCOTAXON

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A new North American species in the lichen genus *Physcia* (Ascomycota) with a unique thallus morphology

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Abstract—A new species belonging to the lichen genus *Physcia* and with an unusual subcrustose growth form is described and illustrated. *Physcia dakotensis*, with a primary distribution in the northern Great Plains, has previously been mistaken for the eastern North American species, *P. subtilis*.

Key words—*Physciaceae,* lichenized fungus, taxonomy

Soon after arriving in North Dakota in 1975, I began regional lichen collecting activities, and soon encountered a tiny, unidentifiable and apparently undescribed, saxicolous lichen species that seemed to belong to the genus *Physcia.* Depending on the color of the rock substrate and the accompanying lichens, this small species can sometimes be almost invisible in the field (sans lens), and a number of my early collections were made as incidental admixtures in collections of other, more conspicuous lichens. Since then, I have encountered a number of larger collections with well developed thalli, some of them among my own collections and some received from other collectors. This species is now known to be at least locally common on rock (especially hard, acidic rock such as granite or quartzite) from the Dakotas to Kansas and Iowa, and I have now seen enough material to formally describe this new taxon. Although the distribution is broader than I originally believed, I have chosen to retain the name I originally used for it:

Physcia dakotensis sp. nov. (Fig. 1 & 2)

Thallus arcte adnatus, subcrustaceus, superne griseus vel griseo-albidus, diameter usque 2 cm, subtus pallidus, rhizinae sparsissimus vel plus minusve absens. Lobi 0.2-0.6 mm lati, lineari-elongati, plus minusve contigua, superficies superior sorediati-isidiati.

Thallus foliose to subcrustose, gray to gray-white, often noticeably darkened on the very lobe-tips; commonly orbicular, most often 1-2 cm in diameter, occasionally larger or appearing larger by coalescent thalli. Lobes flat at the ends, often becoming weakly convex inward, narrow, (0.1) 0.2-0.6 mm in width, more or less linear-elongate and broadening slightly at the tips, often confluent or occasionally somewhat imbricate toward the ends, closely appressed and adnate except right at the tips. Upper surface developing irregular small soralia on internal lobe ends or edges, at first scattered but sometimes becoming abundant, the soredia coarsely granular or becoming more or less upright and strongly isidioid. Medulla white. Lower surface more or less white where visible on the lobe ends, but elsewhere closely appressed to the substrate; rhizines sparse and very poorly developed or essentially absent, usually occurring only as occasional small and irregular pegs. Upper cortex paraplect-enchymatous, the medulla mostly hyphal, lower cortex poorly defined from the medulla or missing, except on the lobe ends where it seems to be little more than compacted hyphae intergrading with the medulla. Apothecia relatively frequent in well developed thalli and sometimes common, up to 0.9 mm in diameter, sessile, more or less flat to weakly concave, the disk black, the exciple entire or occasionally becoming granular isidioid on larger ones; hymenium 80-100 μm thick, ascospores (10) 11-14 (16) x (5.5) 6.5-10 μm, indistinctly *Physcia*-type, the lumina not strongly angular except at an early stage. Pycnidia frequent, often large and conspicuous, partly exposed on the thallus surface; conidia (3.5) 4-5.5 (6.5) x <1-1 μ, more or less rod-shaped, occasionally with a slight bend.

Chemistry: cortex K+ yellow, medulla K- (the medulla is very thin and must be tested very carefully to avoid confusion with the K+ test in the cortex); producing atranorin (identified by TLC).

Type: United States of America. South Dakota. Marshall Co.: along Hwy 25 about 0.4 km S of junction with Hwy 10, just S of Lake City, 45° 42.9' N, 97° 24.58' W, *Esslinger 16030-2* (Holotype, DUKE; Isotypes, US, S, Herb. Essl.).

Selected specimens examined: United States of America. **North Dakota**. Barnes Co.: about 29 km S of Valley City, at Clausen Springs Recreation Area, *Esslinger 5006, 5027* (Herb. Essl.), 19 km W of Valley City, 6.5 km and 2.4 km E of Sanborn, *Trana 2084, 2131, 2138* (MIN), just outside of Valley City, *Trana 1716* (MIN); Morton Co.: ca. 6.4 km S of Mandan at Fort Abraham Lincoln, open prairie, *Esslinger 8410* (Herb. Essl.); Stutsman Co.: Central Grasslands Experiment Station, ca. 13 km NW of Streeter, *Esslinger 8381, 8362* (Herb. Essl.); Kidder Co.: Central Grasslands Experiment Station, *Esslinger s.n.* (Herb. Essl.). **South Dakota**. Brookings Co.: ca. 16 km NW of Brookings at West Oakwood Game Production Area, 44° 27' N, 97° 02' W, *Esslinger 16419, 16420, 16422, 16426* (Herb. Essl.); Deuel Co.: The Nature Conservancy's Altamont Prairie, 44° 53.35' N, 96° 32.06' W, *Wilson4199* (OMA, Herb. Essl.), The Nature Conservancy's Jacobsen Fen Preserve, *Wilson 4198* (OMA, Herb. Essl.); Grant Co.: Blue Cloud Abbey, 45O 15.18"N, *Wilson 4005* (MIN, KANU, OMA, Herb. Essl.); Lincoln Co.: The Nature Conservancy's Wilson Savannah Preserve, 43°09.23' N, 96° 28.29' W, *Wilson 4201* (OMA, Herb. Essl.), Windrows Polo Field, 43° 29.41' N, 96° 35.93' W, *Wilson 4200* (OMA, Herb. Essl.); Minnehaha Co.: Palisades State Park, 43° 41.11' N, 96° 31.51' W, *Wilson 3943, 4179* (Herb. Essl.), 1.6 km S & 1.6 km W of Branden, Big Sioux Recreation Area, 43° 34.85'N, 96° 35.87' W, *Wilson 3576* (OMA. Herb. Essl.); Moody Co.: The Nature Conservancy's Sioux Prairie, 44° 01.75' N, 96° 47.29' W, *Wilson 4191* (Herb. Essl.); Turner Co.: 21 km W and 1.6 km S of Hurley, 43° 15.74' N, 97° 20.33' W, *Wilson 3833* (OMA, Herb. Essl.). **Minnesota**: Brown Co.: Mound Creek County Park, 44° 06.91'N, 95°05.26' W, *Wilson* 4222 (OMA, Herb.

Essl.); Clay Co.: 5.6 km S of Felton, *Thomson 20455* (MIN); Cottonwood Co.: The Nature Conservancy's Red Rocks Preserve, 44° 05.43' N, 95° 01.15' W, *Wilson 4217* (OMA, Herb. Essl.); Lincoln Co. : The Nature Conservancy's Hole in the Mountain Preserve, 44° 14.28' N, 96° 18.13' W, *Wilson, 4194* (OMA, Herb. Essl.); Lyon Co.: Camden State Park, 44° 21.99' N, 95° 56.86' W, *Wilson 4196* (OMA, Herb. Essl.); Pipestone Co.: Pipestone National Monument, 44° 00.62' N, 96° 19.22' W, *Wilson 4193* (OMA, Herb. Essl.); Rock Co.: Blue Mounds State Park, 43° 43.21' N, 96° 11.50' W, *Wilson 4159*, (OMA, Herb. Essl.); Swift Co.: ca. 19.3 km W of Murdock on Rte 33, *Wheeler 16971* (MIN). **Iowa**. Bremer Co.: *Fink*, 1894, 1895 (MIN); Dickinson Co.: The Nature Conservancy's Freda Haffner Kettlehole Preserve, 43° 20.74'N, 95° 13.24'W, *Wilson 4206* (Herb. Essl.), *4207* (OMA, Herb. Essl.); Emmet Co.: Anderson Prairie State Preserve, 43° 26.27' N, 94° 52.25' W, *Wilson 4210* (OMA, Herb. Essl.); Fayette Co.: *Fink*, 1894 (MIN); Lyon Co.: ca. 4.8 km N & 13.7 km W of Larchwood, Gitchie Manitou State Preserve, 43° 30.03' N, 96° 35.50' W, *Wilson 3537* (OMA, Herb. Essl.); Sioux Co.: Oak Grove Park, 1.6 km E & 5.6 km N of Hawarden, 43° 03.3' N, 96° 28.46' W, *Wilson 4204* (OMA, Herb. Essl.). **Kansas**. Chase Co.: 0.8 km S, 4.8 km W of Jct of 240th Rd & Hwy 177 at Cottonwood Falls, 38° 21.95' N, 96° 35.8' W, *Morse 10183* (KANU); Chautauqua Co.: 0.4 km E, 0.4 km S of Chautauqua, 37° 01.38'N, 96°

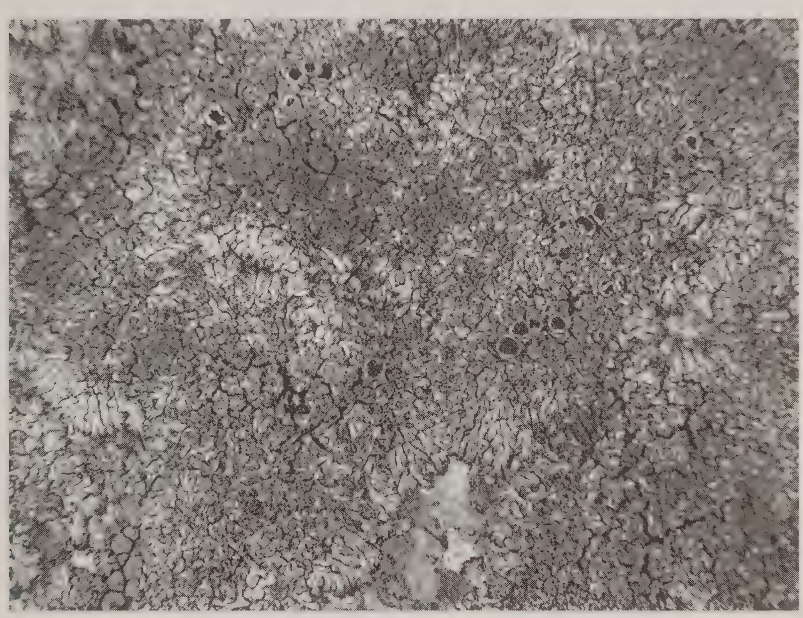

Fig. 1. Part of the holotype of *Physcia dakotensis* (x3).

10.38'W, *Advaita 1999* (Herb. Essl., KANU; with admixture of *P. halei*); Cherokee Co.: 4.8 km E, 0.4 km N of Jct of US Hwy 69 & KS Hwy 96 at Crestline, 37° 10.88' N, 94° 38.98' W, *Morse 10183* (Herb. Essl., with admixture of *P. subtilis*); Douglas Co.: 7.2 km S, 3.6 km W of Stull, 38° 54.04 N, 95° 29.6'W, *Morse 10553* (Herb. Essl., KANU) Labette Co.: 1.6 km N, 7.2 km E of Cherryville, 37° 16.52'N, 95° 28.4' W, *Advaita* 2791 (KANU); Montgomery Co.: 4 km N of Havana, 37° 07.99' N, 95° 56.24' W, *Advaita 2387* (Herb. Essl., KANU); Shawnee Co.: 0.8 km SE of Willard, Herbert Reinhard Green Wildlife Area, 39° 05.03' N, 95° 56.27' W, *Advaita 1371* (Herb. Essl.).

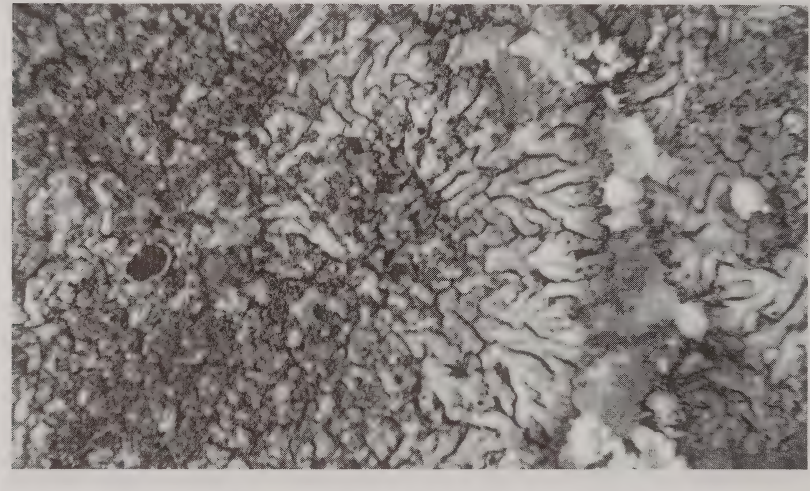

Fig. 2. Closeup of part of the holotype of *Physcia dakotensis* (x7.5)

Although small and easily overlooked, this new species is distinctive and easy to distinguish from other members of the genus. In the past, it is most likely to have been misidentified as *P. subtilis* Degel., a slightly similar, small and saxicolous species (Fig. 3). However, the latter species is sorediate-blastidiate and has a very distinctive lower cortex with well developed and conspicuous rhizines, although these range from sparse to moderately numerous. The thallus habit of *P. subtilis* varies, from distinctly raised off of the substrate to fairly closely appressed, but is never tightly adnate and subcrustose as are most specimens of *P. dakotensis*. In *P. subtilis*, entire thalli or at least large parts of individual lobes are easily removable from the substrate essentially intact, whereas in *P. dakotensis*, thallus removal is impossible and usually only the very end of the lobes are separable from the substrate, and then only while viewing under a dissecting microscope. Among all the specimens examined for this study, only one had been removed from the rock substrate, and it was so fragmented as to be almost unidentifiable. This subcrustose habit appears to be unique among known species of *Physcia*, although two specimens seen from Kansas, which apparently represent a fertile, non-sorediate taxon, are equally if not more closely attached. These possibly represent a new taxon and are still being studied.

The taxonomy of *P. subtilis* and related taxa requires further study. Although *P. subtilis* has been described as having a paraplectenchymatous medulla composed of more or less isodiametric cells, the material seen by me from the Midwest, as well as much of the material from the eastern U.S., has a dense, compactly hyphal to almost prosoplectenchymatous medulla. This material may actually represent a distinct taxon but, regardless, is easily distinguished from *P. dakotensis*.

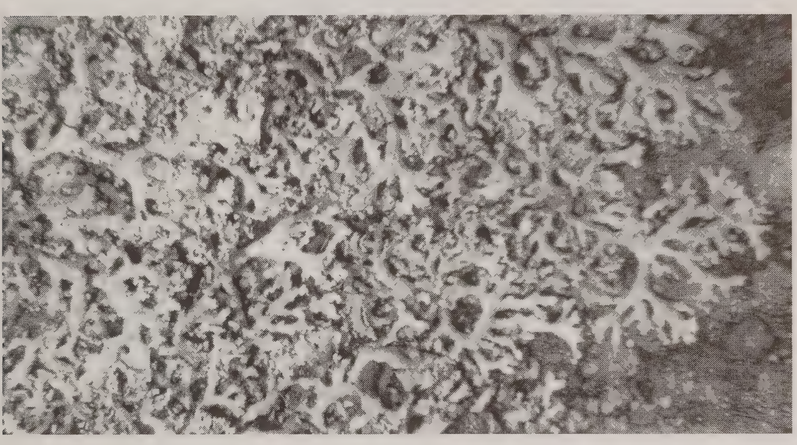

Fig. 3. Closeup of *Physcia subtilis*, Esslinger 3253 (Herb. Essl., x7.5)

Some specimens of *P. dakotensis*, especially the most closely appressed and tightly adnate specimens, on which rhizines can be seen with difficulty if at all, can be reminiscent of certain placodioid species of *Rinodina*. A specimen was sent to John Sheard, who kindly confirmed that he had seen nothing like it described in *Rinodina*.

Apparently, this is the first species to be described in the genus *Physcia* (sensu stricto) that lacks well developed rhizines and has an essentially subcrustose habit. Older treatments of *Physcia*, as well as the most recent North American treatment (Thomson 1963), included subcrustose elements such as today's *Hyperphyscia* within the genus, but these taxa have long been removed from the genus. No species with a subcrustose habit are described in modern works on the genus (e.g. Moberg 1990, 1997, 2002, Nowak 1993). In *P. dakotensis*, only the ends of the lobes are more or less separable from the substrate intact, and even there only a poorly defined lower cortex is visible.

Physcia dakotensis occurs primarily on exposed rock in prairies, pastures, and other very open areas. In the eastern Dakotas, one very common habitat is the piles of field stones occurring in many farm fields, which are mostly composed of granite or similar acidic rock. One specimen from central North Dakota (*Trana 2084*, MIN) was growing on a well-weathered fence post. The distribution as known today, coincides approximately with the northern region of the Great Plains.

Acknowledgements

I wish to thank John Sheard for examining a specimen of this taxon and confirming that it had not previously been described as a *Rinodina*. My gratitude is also extended to Caleb Morse (KANU) and Cliff Wetmore (MIN) for arranging specimen loans, and especially to Nancy Wilson for the gifting of many specimens.

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MYCOTAXON

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Biogeography and hosts of poroid wood decay fungi in North Carolina: species of *Ceriporia, Ceriporiopsis* and *Perenniporia*

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Abstract—Distribution and host plants in North Carolina are given for 6 species of *Ceriporia,* 2 of *Ceriporiopsis* and 10 of *Perenniporia*. A county distribution map is provided for each of the taxa with seven reported for the first time in North Carolina. Numerous new fungus-host plant associations are reported. Species checklists and figures can be accessed at: http://www.cals.ncsu.edu/plantpath/Personnel/Faculty/Grand/mycotaxon_2.pdf

Key words—fungus distribution, polypores

Introduction

The importance of biodiversity and biogeography of fungi was addressed by Grand & Vernia (2004). Previous studies of poroid wood decay fungi in North Carolina provided information on the occurrence and host plants (Vernia & Grand 2000, Grand & Vernia 2002, 2003, Jung 1987). Grand and Vernia (2004) recently reported on the occurrence and host plants of species of *Phellinus* and *Schizopora*. This report is the second in a continuation of a long-term study of poroid wood decay fungi in North Carolina and deals with species of *Ceriporia, Ceriporiopsis* and *Perenniporia.*

Materials and methods

Details of study sites, collection and identification procedures were presented in Grand & Vernia (2004).

Species of fungi on plant hosts were intensively collected from 1997-2003 by the authors. Data from other studies (Grand et al. 1975, Jung 1987), collections in the Mycological Herbarium (NCU), North Carolina State University, records of the Plant Disease and Insect Clinic, Plant Pathology Department, NCSU were used in developing the distribution maps. Likewise, data from the BPI website (Farr et al. n.d.) provided some county data.

Collections were made of all uncommon species of *Ceriporia, Ceriporiopsis* and *Perenniporia*, unusual forms of these species and species on new or unusual hosts. Specimens were identified using existing taxonomic treatments (Breitenbach &

Kraenzlin 1986, Gilbertson & Ryvarden 1986, 1987, Jung 1987, Lowe 1966, Lowe & Gilbertson 1961, Overholts 1953). Nomenclature and authorities are from Gilbertson & Ryvarden (1986, 1987) and Kirk & Ansell (1992) for fungi and Kartesz & Kartesz (1980) for host plants.

The majority of collection sites were in state parks, game lands and natural areas, Nantahala, Pisgah, Croatan and Uwharrie National Forests, the Blue Ridge Parkway and the Great Smoky Mountains National Park. A county distribution map is provided for each species (Figs. 1-18).

Results and discussion

Ceriporia reticulata (Pers.: Fr.) Domanski, *C. viridans* (Berk. & Broome) Donk, *Ceriporiopsis gilvescens* (Bres.) Domanski, *Perenniporia ellipsospora* Ryvarden & Gilb., *P. phloiophila* Gilb. & M. Blackwell, *P. robiniophila* (Murrill) Ryvarden and *P. tephrophora* (Mont.) Ryvarden are reported for the first time in North Carolina.

Only *Ceriporia alachuana* (Murrill) Hallenb. (Fig. 1), *Perenniporia medulla-panis* (Jacq.: Fr.) Donk (Fig. 12), *P. subacida* (Peck) Donk (Fig. 16) and *P. tenuis* (Fig. 17) were collected frequently enough to establish a distributional pattern in North Carolina.

The ranges of *C. reticulata* and *C. viridans* are extended considerably south and east, respectively, of those previously reported for these species (Gilbertson & Ryvarden 1986). The range of *Ceriporiopsis gilvescens* is extended considerably south of previous reports (Gilbertson & Ryvarden 1986). *Perenniporia tephrophora* was previously reported only from Louisiana.

Fifty-five new hosts are reported for the 18 species of *Ceriporia*, *Ceriporiopsis*, and *Perenniporia*. See list of species for specific fungus-host combinations.

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The genus *Lentinus* in Kerala State, India

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Abstract—Nine species of *Lentinus* from Kerala State, India are documented. A new species, *L. dicholamellatus,* is described. *Lentinus polychrous*, *L. strigosus, L. hookerianus*, and *L. similis* are new records for Kerala.

Keywords—*Polyporaceae, Polyporales,* Basidiomycota

Introduction

Although species of *Lentinus* Fr. (*Polyporaceae, Polyporales,* Basidiomycota) are dominant elements of agaricoid mycota of the tropics, very little information is available on the species occurring in Kerala State, India. Manjula (1983), in her revised list of agarics known from India, listed seventeen species of *Lentinus*. From Kerala State, only four species of *Lentinus* have been recorded so far. These include *L. caespiticola* Pat. & Har. (Manimohan & Leelavathy 1995), *L. giganteus* Berk. (Joseph *et al.* 1995), *L. sajor-caju* (Fr.) Fr. (Sathe & Daniel 1980), and *L. squarrosulus* Mont. (Sharma et al. 1985). During our studies on agarics of Kerala, we encountered nine species of *Lentinus,* including a new species, which are documented here.

Materials and Methods

Microscopic observations were made on material mounted in 3% aqueous KOH. Colour codes refer to Kornerup & Wanscher (1978). All collections examined, except those of *L. caespiticola*, are deposited in the National Herbarium of the Netherlands, Leiden (L). *Lentinus caespiticola* collections are at Kew Herbarium (K).

Key to the species

1. Context with skeleto-ligative hyphae; hyphal pegs present 2
1. Context without skeleto-ligative hyphae; hyphal pegs absent 5

2. Lamellae repeatedly furcate; lamellulae very rare or absent;
spores 6-10 x 3-5 μm .... *L. dicholamellatus*

2. Lamellae not repeatedly furcate; lamellulae present 3

3. Pileal surface lacking erect squamules, golden beige;
spores 5-7 x 2-2.5 μm .... *L. sajor-caju*

3. Pileal surface squamose-squarrose 4

4. Pileus cinnamon yellow with concentric zones of fulvous or darker recurved
squamules; spores 7-9 x 2-3 μm .... *L. polychrous*

4. Pileus whitish to cream-coloured, with concentric zones of whitish or
brownish squamules; spores 5-7 x 1.7 μm ....*L. squarrosulus*

5. Hymenophoral cystidia present as either gloeocystidia or metuloids 6

5. Gloeocystidia or metuloids are absent; sometimes skeletocystidia
may be present-.. 7

6. Basidiomata small; graminicolous; hymenium with gloeocystidia;
spores 5-7.5 x 4- 5.5 μm .... *L. caespiticola*

6. Basidiomata medium-sized to large; not graminicolous; gloeocystidia
absent but metuloids present; spores 4-6.5 x 2-3.5 μm ....*L. strigosus*

7. Pileal surface glabrescent or with appressed-fibrillose squamules;
spores 5-7 x 4-4.5 μm, ovo-elliptical .... *L. giganteus*

7. Pileal and stipe surface velutinate to hispid-strigose; spores different........... 8

8. Pileus 2-4.5 cm diam.; surface densely villose to hispid-strigose; no striations or zonations; lamellae crowded; stipe 1-2 cm x 4-6 mm, not arising from a sclerotium or pseudosclerotium; spores 5-6.5 x 3-4 um, ovo-ellipsoid in shape ....*L. hookerianus*

8. Pileus 5-10 cm diam.; surface finely velutinate with closely plicate-striate; lamellae subdistant to close; stipe 4-9 cm x 3-8 mm, arising from a pseudosclerotium; spores 5-7 x 2.5-3 μm, oblong-cylindrical in shape ....*L. similis*

Description of new species

Lentinus dicholamellatus Manim. *sp. nov.* **FIGURES 1-2**

Pileus 1-16 cm latus, primo convexo-umbilicatus, postea infundibuliformis, primo pallide luteus, postea atrobrunneus, subtiliter fibrilloso-striatus, squamulis appressis minutis praeditus. Lamellae decurrentes, luteoalbidae, confertae, angustae, repetite furcatae. Lamellulae nullae vel inusitatae. Stipes 1.5-10 cm x 3-20 mm, centralis, cylindricus, solidus, primo luteoalbidus, postea brunneus, tomentosus, saepe squamulosus. Sporae 6-10 x 3-5 µm, oblongo-ellipsoideae vel subcylindricae. Basidia 15-29 x 4.5-9 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 8-47 x 3-7 µm, sinuoso-cylindrica, raro nodulosa, crassitunicata, atro brunnea. Pleurocystidia nulla. Paxillae hypharum praesentiae. Trama hymenophoralis ex hyphis radiatis instructa. Systema hypharum dimitica; hyphae generatoriae 2-6 µm latae, tenuitunicatae, hyalinae; hyphae skeleto-ligativae 2-6 µm latae, crassitunicatae, hyalinae, ramosae. Epicutis pilei disrupta, ex hyphis 2-7 µm latis luteobrunneis fibulatis crassitunicatis composita. Ad lignum putrescens.

Basidiomata medium-sized to large and robust, growing scattered or in small or large clusters on decaying wood. **Pileus** 1-16 cm in diam., initially convex with a depressed centre, becoming deeply infundibuliform; surface initially pale yellow (4A2/4A3),

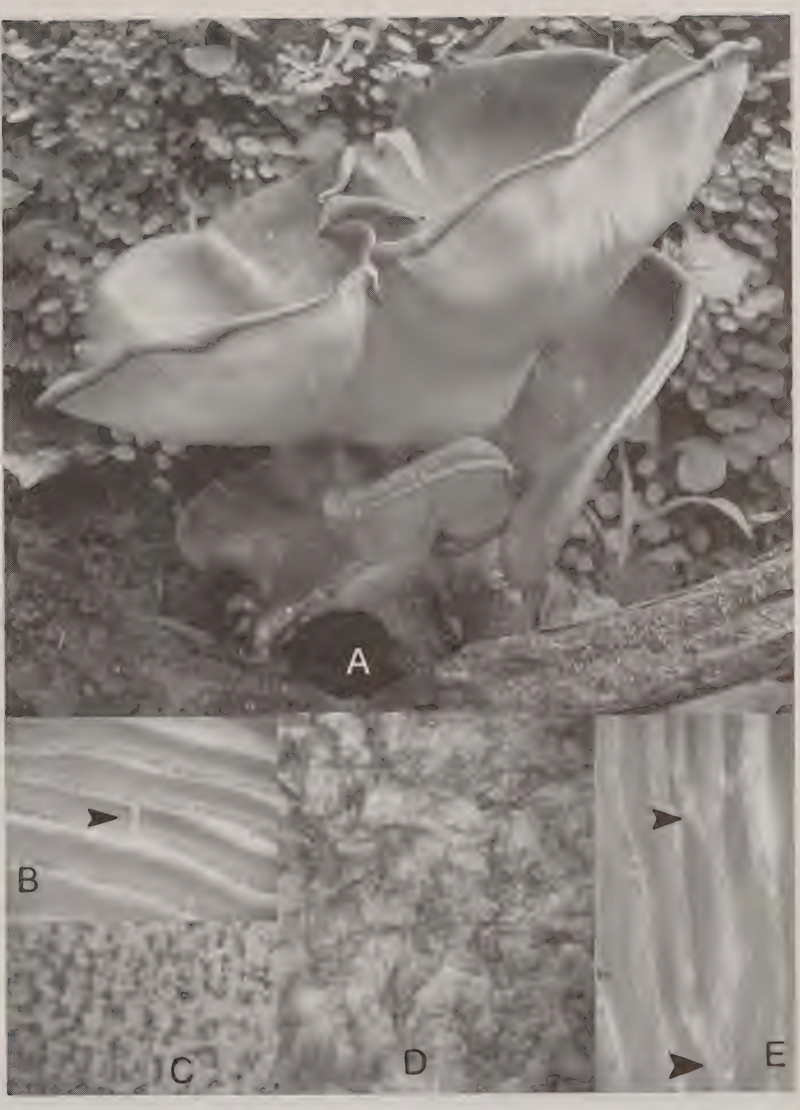

Fig. 1. *Lentinus dicholamellatus*: A, basidiomata, x 0.7; B, bridge-like structures connecting adjacent lamellae (arrow), x 8; C, squamules of pileal surface, x 3; D, squamules of stipe surface, x 4; E, repeatedly furcate lamellae (arrows), x 8.

changing through greyish orange (5B4), brownish orange (5C4) or greyish brown (5E4/5E5) and finally becoming dark brown (6F6), finely radially fibrillose-striate to the naked eye, under a lens densely dotted with very fine appressed or erect squamules; margin incurved and remaining so, entire becoming undulate or lobate. **Context** pale yellow (3A3/4A2), 1 mm or less wide. **Lamellae** deeply decurrent, crowded, yellowish white (4A2), less than 1.5 mm wide; lamellulae very few or even absent but lamellae often repeatedly furcate at several levels; edge finely fimbriate and spotted greyish brown under a lens. **Stipe** 1.5-10 cm x 3-20 mm, central or eccentric, almost equal or slightly tapering towards base, terete, solid; surface initially yellowish white (4A2), becoming greyish brown (6E4) or brown (8F4), tomentose, sometimes dotted with erect pointed squamules; base not attached to a pseudo- or true sclerotium. **Odour** not distinctive.

Spores 6-10 x 3-5 (7.68±1.08 x 4.35±0.45) μm, Q = 1.25-2.33, Qm = 1.79, mostly oblong-ellipsoid to subcylindric, some widely ellipsoid, ellipsoid or cylindric, hyaline, thin-walled, smooth, inamyloid. **Basidia** 15-29 x 4.5-9 μm, clavate to cylindrico-clavate, 4-spored; sterigmata up to 3 μm long. Lamella-edge sterile. **Cheilocystidia** 8-47 x 3-7 μm, sinuous-cylindric, rarely nodulose, thick-walled, with a dark brown wall pigment, often with basal clamp connections. **Pleurocystidia** absent. **Hyphal pegs** scattered on the hymenium, 62.5-185 x 37.5-87.5 μm, projecting up to 150 μm beyond the hymenial surface, conic to somewhat cylindric, composed of thin-walled hyphae. Structures identical to hyphal pegs in all aspects but interconnecting adjacent lamellae frequently seen towards the lamella-edges. **Lamellar trama** irregular, of radiate construction; dimitic, composed predominantly of skeleto-ligative hyphae, 2-6 μm wide, with a thick wall up to 1.5 μm wide, hyaline, with gradually tapering branches; generative hyphae 2-6 μm wide, thin- to slightly thick-walled, septate, branched, with prominent clamp-connections. **Pileal trama** inter-woven, dimitic; hyphae similar to those of lamellar trama. **Pileipellis** a cutis of thick-walled generative hyphae frequently disrupted by bundles of loosely aggregated erect hyphae or ascending or erect bundles of cystidioid end-cells similar to cheilocystidia; hyphae 2-7 μm wide, thick-walled, with a pale yellowish to dark yellowish brown wall and sometimes with dark brown encrustations, with clamp-connections. **Stipitipellis** a trichodermium composed of 1.5-7 μm wide, thin- to slightly thick-walled, pale yellowish to yellow brown generative hyphae with frequent clamp connections: squamules of the stipe surface composed of ascending or erect, 300-650 μm long bundles of 1.5-3.5 μm wide, slightly thick-walled, dark brown hyphae.

COLLECTIONS EXAMINED — INDIA, **KERALA STATE, Malappuram District,** CALICUT UNIVERSITY CAMPUS: 2 August 2003, *P. Manimohan, M796*; 2 August 2003, *N. Divya, D8*; 6 August 2003, *P. Manimohan, M797*; 7 August 2003, *P. Manimohan, M798* (**holotype**); 7 August 2003, *P. Manimohan, M799* (all at L).

Repeatedly furcate lamellae, near absence of lamellulae, presence of both skeleto-ligative hyphae and hyphal pegs, and the uninflating generative hyphae together place this species in section *Dicholamellatae* Pegler of the subgenus *Lentinus*. It does not agree with any of the three species admitted by Pegler (1983) in that section. The Southeast Asian species *L. badius* (Berk.) Berk., and the Australasian species *L. araucariae* Har. & Pat. show the following differences: distinctive subpyramidal pseudoparenchymatous velar squamules on the pileal surface, smaller spores, absence

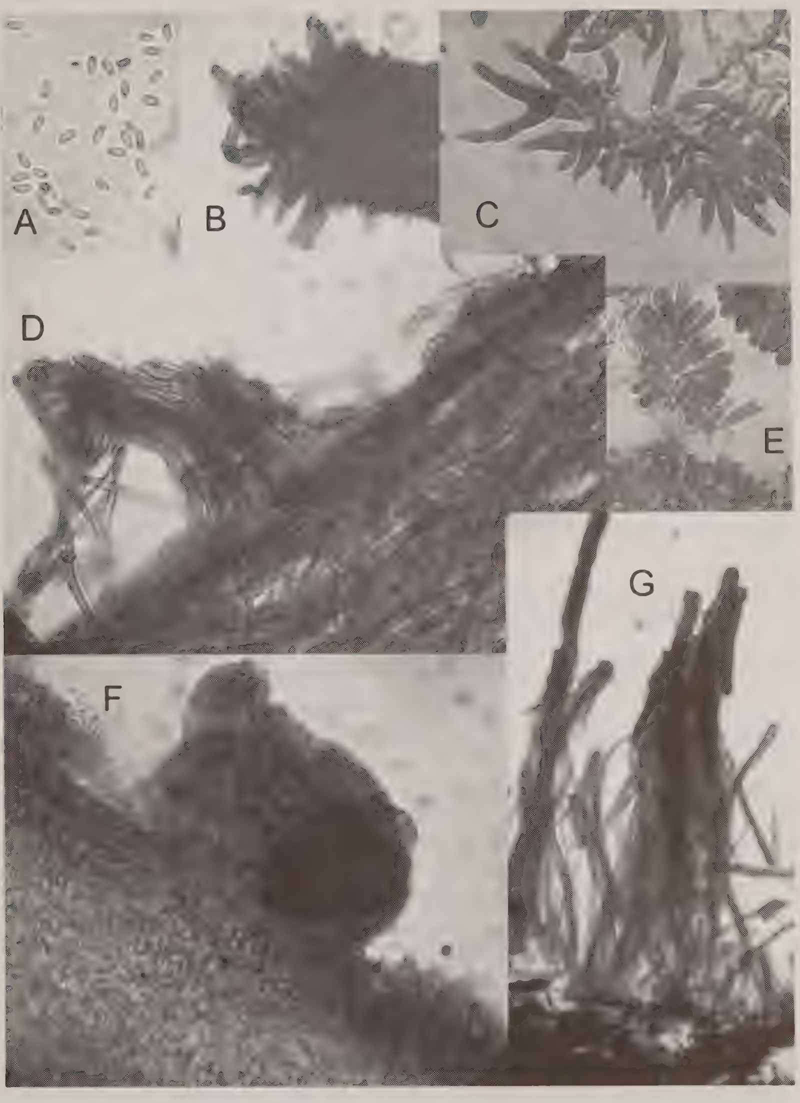

Fig. 2. *Lentinus dicholamellatus:* A, spores, x 300; B, lamella-edge, x 400; C, cheilocystidia, x 500; D, pileipellis, x 400; E, basidia, x 450; F, hyphal peg, x 500; G, stipitipellis, x 100.

of both cheilocystidia and emerging hyphae on the lamella-edge, extremely abundant hyphal pegs, wider (up to 12.5 μm) skeleto-ligative hyphae with a much thicker (up to 4 μm) wall, and a gelatinized hypodermium. The African species *L. brunneofloccosus* Pegler is characterized by a complete absence of hyphal pegs in the hymenium, and large, thick, detersile squamules on the pileal surface. Apart from these differences, *L. dicholamellatus* shows one unique feature: the adjacent lamellae are often interconnected by bridge-like structures (Fig. 1B), which are strikingly similar to hyphal pegs in morphology and composition. These structures are usually seen towards the lamella-edge. This seems to be a consistent feature of this species as we observed them in all the specimens of *L. dicholamellatus* examined by us although their frequency ranged from very frequent to very sparse.

Comments on other species

***Lentinus sajor-caju* (Fr.) Fr.,** Epicrisis: 393. 1838.

Although this species is widely referred to as *Pleurotus sajor-caju* (Fr.) Singer, it is a true *Lentinus* species owing to the presence of skeleto-ligative hyphae. The Kerala collections agree remarkably closely with those described by Pegler (1983) and do not show any kind of disagreement in any feature. The spores measured 5-7 x 2-2.5 μm.

Collections examined — **INDIA**, **Kerala State**, **Thiruvananthapuram District**, Palode, TBGRI campus: 4 May 1996, *K. B. Vrinda, TBGT3010*; 26 June 1996, *K. B. Vrinda, TBGT5841* (all at L).

***Lentinus polychrous* Lév.,** Ann. Sci. Nat., Bot. ser. 3, 2: 175. 1844.

Lentinus polychrous is a species confined to South and Southeast Asia. Although Pegler (1983) described this species as dimitic, Corner (1981) described it to be almost trimitic. Our observation of the Kerala collection revealed distinct generative, skeletal, and skeleto-ligative hyphae and thus it confirms Corner's observation. According to Pegler (1983), it is rare to encounter a fertile hymenophore in this species. Supporting this observation, basidia were not observed in one of the two collections made in Kerala. Spores of our collections measured 6-9(10) x 2.5-3(4) μm.

Collections examined — **INDIA**, **Kerala State**, **Ernakulam District**, Iringole Sacred Grove: 20 August 1994, *K. B. Vrinda, TBGT1440*; **Thiruvananthapuram District**, Palode, TBGRI Campus: 29 March 1995, *K. B. Vrinda, TBGT2004* (all at L).

***Lentinus squarrosulus* Mont.,** Ann. Sci. Nat. Bot. Ser.2., 18: 21. 1842.

Lentinus squarrosulus is a paleotropical species showing wide distribution. According to Pegler (1983), the fungus reported as *L. crinitus* by Natarajan & Raman (1981) from southern India represents *L. squarrosulus*. Spores of the Kerala collections measured 5-7.5 x 1.75-3 μm.

Collections examined — **INDIA**, **Kerala State**, **Ernakulam District**, Iringole Sacred Grove: 15 October 1994, *K. B. Vrinda, TBGT1773*; **Thiruvananthapuram District**, Palode, TBGRI campus: 25 November 1993, *K. B. Vrinda, TBGT437*; **Palakkad District**, Dhoni: 23 February 1996, *K. B. Vrinda, TBGT3734*; **Malappuram District**, Calicut University Campus: 26 July, 2003, *N. Divya, D5*; 21 October, 2003, *P. Manimohan, M800*; 18 November 2003, *Arun Kumar, AK14* (all at L).

***Lentinus caespiticola* Pat. & Har.,** J. Bot., Paris 14: 240. 1900.

Lentinus caespiticola is unique among species of *Lentinus* in that it is graminicolous. Manimohan & Leelavathy (1995) observed that the collections made from Kerala State never showed the caespitose habit, one of the characteristic features of this species, and hence they erected a new variety, *L. caespiticola* var. *asiaticus* Manim. & Leelav., based on the Kerala collections. Spores of the Kerala collections measured 5-7.5 x 4-5.5 μm. A full description of the Kerala collections is given in Manimohan & Leelavathy (1995) and we fully agree with their observations and conclusions.

Collections examined — INDIA, Kerala State, **Malappuram District**, Calicut University Campus: 23 October 1990, *P. Manimohan, K(M)25899*; 24 October 1990, *P. Manimohan, K(M)25900*; 29 September 1992, *P. Manimohan, K(M)25901*; 30 September 1992, *P. Manimohan, K(M)25902*; 26 October 1993, *P. Manimohan, K(M)25898* (all at K).

***Lentinus strigosus* (Schwein.) Fr.,** Syst. Orb. Veg.:77. 1825.

Lentinus strigosus has a geographical distribution ranging from the tropics to subtemperate regions. The distinguishing features of the species are the short, eccentric, hispid stipe, the pale-coloured pileus lacking striations and zonations, the small ellipsoid spores and the large metuloidal cystidia. The Kerala collections nicely fit into the description of the species given by Pegler (1983). Spores of our collections measured 4-6.5 x 2-3.5 μm.

Collections examined — INDIA, Kerala State, **Wayanad District**, Mundakkai: 12 September 1985, *P. Manimohan, M341*; **Kannur District**, Pulikurumba: 23 September 1997, *P. Manimohan, M730* (all at L).

***Lentinus giganteus* Berk.,** Hooker Lond. Journ. Bot. 6: 493. 1847.

Our collections agree with L. *giganteus* in almost all features except that they lack caulocystidia, which were observed by Pegler (1983). Spores of the present collections measured 5-7 x 4-4.5 μm.

Collections examined — INDIA, Kerala State, **Malappuram District**, Calicut University Campus: 20 September 2001, *P. Manimohan, M764*; 1 June 2001, *P. Manimohan, M760*; **Thiruvananthapuram District**, Palode, TBGRI campus: 6 November 1993, *K. B. Vrinda, TBGT256*; 27 October 1994, *K. B. Vrinda, TBGT1843*; 3 November 1994, *K. B. Vrinda TBGT1885*; 11 May 2001, *C. K. Pradeep, TBGT5303*; **Thiruvananthapuram District**, Kallar: 18 April 1996, *C. K. Pradeep, TBGT2916* (all at L).

***Lentinus hookerianus* Berk.,** Hooker Journ. Bot. & Kew Misc. 3:44. 1851.

Lentinus hookerianus had so far been known only from West Bengal (Pegler, 1983). The Kerala collection agrees with Pegler's (1983) description of the species in most macroscopic and microscopic characters. However, a few minor differences could be observed. According to Pegler (1983), the fasciculate hairs on the pileal surface are 1-2 mm long whereas the hairs were consistently less than 1 mm in the present collection. Another deviation is the presence of thin-walled cystidia similar to cheilocystidia on the sides of the lamellae. Spores of the Kerala collections measured 5-6.5 x 3-4 μm.

Collection examined — INDIA, Kerala State, **Malappuram District**, Calicut University Campus: 6 July 1999, *P. Manimohan, M606* (at L).

***Lentinus similis* Berk. & Broome,** Journ. Linn. Soc., Bot. 14: 43. 1873.

Lentinus similis is strikingly similar to *L. ciliatus* Lév. in several macroscopic and microscopic features. The former, however, can be differentiated in the field itself because of its radially plicate-sulcate pileus. The Kerala collections, the spores of which measured 5-7 x 2.5-3 μm, fully agree with the description of *L. similis* given by Pegler (1983).

Collections examined — **INDIA, Kerala State, Wayanad District**, Mundakkai: 12 September 1985, *P. Manimohan, M340*; **Kannur District**, Pulikurumba: 5 August 1997, *P. Manimohan, M717*; **Thiruvananthapuram District**, Palode, TBGRI campus: 19 October 1993, *C. K. Pradeep, TBGT35* (all at L).

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Changes and additions to the Checklist of North American Lichens. - II

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Abstract—*Graphis rigidula* and *Vezdaea retigera* are reported for the first time from North America. *Placidium tuckermanii* has been found to be a junior synonym of *Endocarpon arboreum*. Thus, the new combination *Placidium arboreum* is proposed. *Lecanora deplanans* is placed in synonymy with *Ionaspis lacustris*. The following names are lectotypified: *Endocarpon arboreum, Endocarpon tuckermanii, Lecanora deplanans.*

1. ***Graphis rigidula*** Müll. Arg.

Graphis rigidula is reported for the first time from North America on the basis of several collections from North Carolina cited below. The species was found growing on the bark of slightly shaded trees and occurred with *Byssoloma* sp., *Gyrostomum scyphuliferum* (Acharius) Nylander, *Phaeographis dendritica* (Acharius) Müll. Arg., *P. lobata* (Eschweiler) Müll. Arg., *Sarcographa tricosa* (Acharius) Müll. Arg., and a sterile sorediate species of *Thelotremataceae*. *Graphis rigidula* is easily distinguished from other North American species of *Graphis* by the combination of a striate, fully carbonized lateral exciple (lacking below), lack of lichen substances, and colorless (10)-13-14 celled ascospores, that are 8-per ascus and (40)-50-65 x (8)-9-11μm.

Specimens Examined. – USA. NORTH CAROLINA. BRUNSWICK COUNTY: Dense maritime forest with large *Quercus virginiana*, mostly in various stages of destruction for residential development, Bald Head Island. *Lendemer 1320 & Yahr* (DUKE!, NY!, hb Lendemer!), *Lendemer 1628 & Yahr* (DUKE!, NY!, SBBG!, hb. Lendemer!), *Yahr 4832 & Lendemer* (DUKE!), *Yahr 4866 & Lendemer* (DUKE!).

2. *Ionaspis lacustris* (Withering) Lutzoni

Lichen lacustris Withering, Arr. Brit. pl. ed. 3, 4: 21. 1796. TYPE: Griffith (BM, not seen).

Ionaspis lacustris (Withering) Lutzoni, Sys. Bot., 20: 253. 1995. (full synonymy not provided here)

Syn. nov. *Lecanora deplanans* Nylander, *in* Millspaugh & Nuttall, Bot. Gaz., 22(4): 334. 1896. TYPE: On sandstone, [Short Creek], West Virginia, USA. *W.W Calkins s.n.* (H-NYL #24809!, lectotype [**selected here**]; NY!, PH!, probable isolectotypes).

The type material of *Lecanora deplanans* was identified as *Lecanora lacustris* (= *Ionaspis lacustris*) by Weber (1958, annotation) however the synonymy does not appear to have been formally published and the name *L. deplanans* remains on the North American checklist (Esslinger 1997). It should be noted that though the protologue cites L.W. Nuttall as the collector of the type, the specimen in H-NYL selected here as the lectotype was labeled by Nylander as having been collected by W.W. Calkins. The probable duplicate in PH lists L.W. Nuttall as the collector. This type of confusion is often encountered when attempting to typify taxa based on material sent to experts by W.W. Calkins. Refer to Brodo et al. (2001) for a description of *I. lacustris*.

3. Placidium arboreum (Schweinitz *ex* Michener) Lendemer *comb. nov.*

Endocarpon arboreum Schweinitz MSS, *in* herb. Schweinitz (PH)

Endocarpon arboreum Schweinitz *ex* Fries *nomen nudum*, Lich. Eur. Ref. p.407. 1831.

Endocarpon arboreum Schweinitz *ex* Michener *in* Darlington, Flora Cestrica, ed. 3, p.451. 1853. TYPE: On bark, sine loc., USA. *Schweinitz* s.n. (PH #991055c!, lectotype [**selected here**]).

Dermatocarpon arboreum (Schweinitz *ex* Fries) Fink, Lichens Minn. p. 244. 1910.

Syn. nov. *Endocarpon tuckermanii* Ravenel MSS, *in* herb. Tuckerman (FH-TUCK)

Endocarpon tuckermanii Montagne, Sylloge Gener. Spec. Cryptog. p. 359. 1856. TYPE: On *Carya sp.*, among mosses, Santee Canal, South Carolina, USA, *H.W. Ravenel* #138 = Reliquiae Tuckermanianae, no. 42 (FH-TUCK!, lectotype [**selected here**]; FH!, UC!, US!, isolectotypes).

Endopyrenium tuckermanii (Montagne) Müll. Arg., Bot. Jahrb., 6: 377. 1885.

Dermatocarpon tuckermanii (Montagne) Zahlbuckner, Cat. Lich. Univ. 1: 238. 1921.

Catapyrenium tuckermanii (Montagne) Thomson, Bryologst, 90: 36. 1987.

Placidium tuckermanii (Montagne) Breuss, Ann. Natur. Mus. Wien 98B: 39. 1996.

The name *Endocarpon arboreum* was originally proposed by Schweinitz in manuscript form. Elias Fries (1831) first published the name noting it to be "a poorly developed *Sticta*". Clearly Fries did not accept *E. arboreum* and thus this publication of the name by Fries must be considered a *nomen nudum*. Later authors, e.g. Thomson (1987), and Breuss (1996) have used the epithet "*tuckermanii*" for this lichen, however, Michener had published a valid description of *Endocarpon arboreum* in Darlington's

Flora Cestrica three years prior to the publication of the name *Endocarpon tuckermanii* by Montagne (1856). See Thomson (1987) or Brodo et al. (2001) for a description of this species under the names *Catapyrenium tuckermanii* and *Placidium tuckermanii* respectively.

4. ***Vezdaea retigera*** Poelt & Döbbeler

The genus *Vezdaea* includes a number of inconspicuous taxa that are often confined to disturbance based habitats. The most common species, *V. leprosa* (P. James) Vězda, was only recently reported from North America (Buck et al., 1999) and two additional species have been reported since (Brodo 2001, Westberg 2004). The report of another species is thus not unexpected. The collection of *V. retigera* reported here was found overgrowing organic matter and bryophytes along a roadside and was associated with an undetermined sterile sorediate crust, *Porpidia crustulata* (Acharius) Hertel & Knoph, *Trapelia placodioides* Coppins & P. James, and *Xanthoparmelia* spp. For a description of *V. retigera* refer to Poelt & Döbbeler (1975).

Specimens Examined. – USA. PENNSYLVANIA. SULLIVAN COUNTY: Mixed northern hardwood forest with gradation from primarily *Acer, Fraxinus,* and *Betula* to hemlock (*Tsuga*), with shaded boulders, on a north facing slope, area around amphitheater, east of Mineral Spring Road along Loyalsock Creek, Worlds End State Park. *Lendemer 2284 & Macklin* (NY!, hb. Lendemer!).

Acknowledgements

We wish to thank Richard C. Harris (NY) for reviewing the manuscript as well as determining the specimens reported here as *Vezdaea retigera* and confirming a collection *Graphis rigidula*. Also, Kerry Knudsen for providing helpful commentary and discussion as well as reviewing the manuscript. We also thank Orvo Vitikainen for loaning the specimens from H-NYL; the curators of the following herbaria for loaning material of *Placidium arboreum*: ASU, FH, MIN, NY, UC, US.

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A taxonomic study of the family *Podoscyphaceae* (Basidiomycetes), new species and new records in Cameroon

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Abstract — Two species of *Cymatoderma*, ten species of *Podoscypha* and three species of *Stereopsis* are recorded from the Mbalmayo forest reserve, Cameroon. *C. elegans, P. nitidula, P. petalodes* subsp. *rosulata, P. simulans, S. hiscens* f. *rosea* and *S. radicans* are new to Cameroon. *P. disseminata* sp. nov. is described and illustrated. A key to species of *Podoscyphaceae* in Cameroon is provided.

Key words — *Podoscypha disseminata*, stipitate steroid fungi, survey

Introduction

The family *Podocyphaceae* Reid (1965) was proposed to accommodate stipitate steroid fungi belonging to the genera *Podoscypha* Pat., *Cymatoderma* Jungh., *Stereopsis* D. A. Reid, *Cotylidia* P. Karst., *Inflatostereum* D. A. Reid and *Aquascypha* D. A. Reid, with *Podoscypha* as the type genus. The remaining taxa were grouped in the family *Lachnocladiaceae* D. A. Reid with *Lachnocladium* Lév. emend. Corner as the type genus. The former family encompasses taxa characterized by spathulate to infundibuliform basidiomata, upper surface glabrous to hirsute, hyphal system mono-, di- to trimitic, cystidia and gloeocystidia often present and always with smooth spores. While in the latter, basidiomata are resupinate, clavarioid to spathulate, hyphal system dimitic with dichophitic binding hyphae and basidiospores smooth, verrucose or echinulate. This paper deals with the diversity of the family *Podoscyphaceae,* with special emphasis on the genera *Cymatoderma*, *Podoscypha* and *Stereopsis* occurring in Cameroon.

In contrast to the African fungal flora as a whole, which is still understudied, African species of *Podoscyphaceae* are relatively well known (Boidin, 1966). The family is widely distributed in tropical and subtropical regions with some endemic taxa. In the most important work on stipitate steroid fungi to date, Reid (1965) reported four genera of *Podoscyphaceae* from Africa, including about seventeen species, in which nine species of *Podoscypha*, one species of *Cotylidia*, four species of *Cymatoderma* and three species of *Stereopsis*. He reported twenty-six species of *Podoscypha,* nine species of *Cymatoderma* and ten species of *Stereopsis* for the world mycobiota. In the following years, many new taxa have been described and other varieties accepted on specific level (Berthelet & Boidin, 1996; Boidin & Lanquetin, 1973; Ryvarden, 1997; Wu, 2003).

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Earlier contributions to the *Podoscyphaceae* in Central Africa are the works of Boidin (1961 & 1966) with special emphasis on Congo and Central African Republic with extension to surrounding countries as Cameroon, a new species *P. nuda* Boidin was described. None of the various studies on the Basidiomycetes in Cameroon (Berthet & Boidin, 1966; Hjortstam & *al.*, 1993; Calonge & Daniëls, 1998; Núñez & Daniëls, 1999; Roberts 1999, 2000 and 2001) has been exclusively focused on the *Podoscyphaceae*. Nevertheless, based on the scanty and fragmentary data available, up to fourteen species of *Podoscyphaceae* are reported from Cameroon (Boidin, 1961, 1966; Boidin & Lanquetin, 1973; Hjortstam & *al.*, 1993). In the framework of the survey on the Southern Cameroon mycoflora, twenty-five collections resulting from three years (2001-2003) monitoring in the Mbalmayo forest reserve lead the report of fifteen taxa of *Podoscyphaceae,* all previously not reported for this area, with six taxa representing new records for Cameroon. Furthermore, after thorough microscopic study and literature survey, some specimens appear to represent undescribed species that is herein proposed as new. Hitherto reported species of *Podoscyphaceae* from Cameroon are keyed.

Material and Methods

The specimens were collected in the Mbalmayo Forest Reserve (MFR) located about 47 km southern of Yaoundé, an area of 9700 ha lying between 500-650 m asl. (11° 54´E, 3° 58´N). Morphological description was based on fresh material. Microscopic structures were mainly observed on dried material. Free-hand thin sections were mounted in 5% KOH unless otherwise noted. Optical microscopy studies were carried out at 400 and 1000 X using an Olympus BX51TF microscope. Size ranges of basidiospores were based on ocular micrometer measurements. E value is the length divided by the width of the basidiospore and Q value is the mean of E of N = 30 basidiospores. Light photography was done with a Nikon COOLPIX 4500 Digital, and processed in Photoshop (Adobe Photoshop 4.0). Line drawings were made using a grid as drawing aid representing a magnitude of × 2000. Colour terms in parentheses are those of Kornerup & Wanscher (1978). The species mentioned are arranged alphabetically. The new records for Cameroon are marked with an asterisk (*). The herbaria are cited according to Holmgren et al. (1990). The following notes are based on our collections and other African specimens preserved in the National Botanic Garden of Belgium (BR). Specimens are deposited at the herbarium of Cryptogamy Laboratory, Faculty of Science, University of Yaounde I, Cameroon (HUYI).

Taxonomy

New species

Podoscypha disseminata Douanla-Meli **sp. nov.** PLATE 1; FIGURE 1

Basidiomata usque 1-2 cm alta, 05-1.5 cm lata, flabelliformia vel perfecte infundibuliformia; Pileus pureo-brunneus. Superficies superior glabra, non zonatus. Superficies inferior pruinosa. Hypharum systema dimiticum. Chlamydosporae 6-12 × 5-9 µm, copiosa, hyalinae, *muris crassis, globosae, subglobosae vel ovatae. Pileocystidia usque ad 70 µm longa et 13-20 µm lata, cylindrica vel subcylindrica, muris crassis, copiosa septis instructa. Caulocystidia (45-)50–100 × 16-21.5 µm, pilocystidiis similia, muris crassis. Cystidia nulla. Gloeocystidia (30-)40-110 × (4-)6-10 µm, copiosa fusiformia, elongata, subcylindrica sed basi inflata, muris tenuibus instructa. Basidia usque (16-)22-39 × 3.5-5 µm, cylindrica vel subclavata, unispora vel bispora. Basidiosporae (4-)4.5-6(-7) × (2.5-)3-4(-4.5) µm, ellipsoidae vel ovatae.*

Ad Mbalmayo silva nova Oyack II-Cameroon, m 500-650 a.s.l., 11° 54′ E, 3° 58′ N, on emortuus lignum, leg. C. Douanla-Meli, 09.X.2002. Holotype: herb. HUYI DMC 232, Isotype in O.

Etymology— The epithet *disseminata* refers to the smaller habit clustered on dead wood.

Basidiomata erect, stipitate, funnel-shaped, infundibuliform with a swallow cup, at times enrolled and appear cylindrical to setiform, or flabellate narrowing behind into a very short stipe, clustered or growing in colonies of discrete basidiomata, not concrescent, 1-2 cm from the base of the stalk to the margin, and up to 0.5-1.5 cm wide; **Pileus** leathery, glabrous, shining, almost translucent, brownish yellow (5C8), brown (6D6) to brown orange (6C8) on fresh, fading upon drying to red brown (10C8), azonate, margin entire and may become deeply indented; hymenial surface smooth, concoloured with the upper surface on fresh, becoming greyish white (-B1), pruinose; **Stipe** up to 0.4-1.2 cm long and 1-1.5 mm in width, rudimentary to distinct, round to flattened, concoloured, turning grey brownish (6E2-6E4), glabrous towards the hymenophore and covered below with a tuff of whitish stiff hairs, equal to slightly tapering towards the base, and attached to the substrate by a yellowish pale (2A3), distinct basal mycelial disc; **Context** thin, less than 1mm thick, brown beige (6E3).

Hyphal system dimitic, consisting of generative and skeletal hyphae. The generative hyphae 2-5 µm in diameter, strongly branched, bearing prominent clamp connections at the septa, hyaline, thin-walled. Skeletal hyphae 2-6 µm in diameter, not branched, hyaline, with refractive, thickened walls; **Chlamydospores** very abundant throughout the pileus, the hymenial layers and the stipe, arising as terminal swellings on very short side branches of the generative hyphae, hyaline, the inner part occupied by a large vacuole or numerous small globules, with a strongly thickened, smooth walls, which appear to be double, variable in size and shape, 6-12 × 5-9 µm, globose, subglobose, ovate to pyriform; **Gloeocystidia** present, with variable size ranging from (30-)40-110 × (4-)6-10 µm, thin-walled, fusoid with swollen base to subcylindrical, at times contorted or strangulated, gradually tapering towards the obtuse apices, arising at any level of the hymenium, immerge in the thickening hymenium, few traverse the entire width, but occasionally exceeding the level of the basidia, then up to 20 µm; **Cystidia** absent; **Pileocystidia** up to 70 µm in length and 13-20 µm wide, subcylindrical to cylindrical, with broadly rounded apices, hyaline, thick-walled, almost with frequent transverse septa, much scanty at the surface of the cap, having a deep seated origin, continuing as thick-walled skeletal hyphae; **Caulocystidia** variable in size, (45-)50-100 × 16-21.5 µm, abundant, similar in shape to the pileocystidia, but usually rather larger and longer, hyaline, thickened walls of up to 4 µm, with numerous transverse septa, cylindrical and slightly tapering at the base, pedunculate, continuing as a skeletal hyphae; **Basidia** (16-)22-39 × 3.5-5 µm, cylindrical to subclavate, with 1-2 long sterigmata, of up to 10 µm long, almost filled with both small and large oil droplets, thin-walled, matured basidia projecting beyond the palisade of up to 7 µm, also numerous basidioles present;

Basidiospores white in mass, (4-)4.5-6(-7) × (2.5-)3-4(-4.5) µm, E = 1.3-1.8; Q = 1.4, broadly ellipsoid to ovate, hyaline in KOH, thin-walled, smooth, with a single large oil drop.

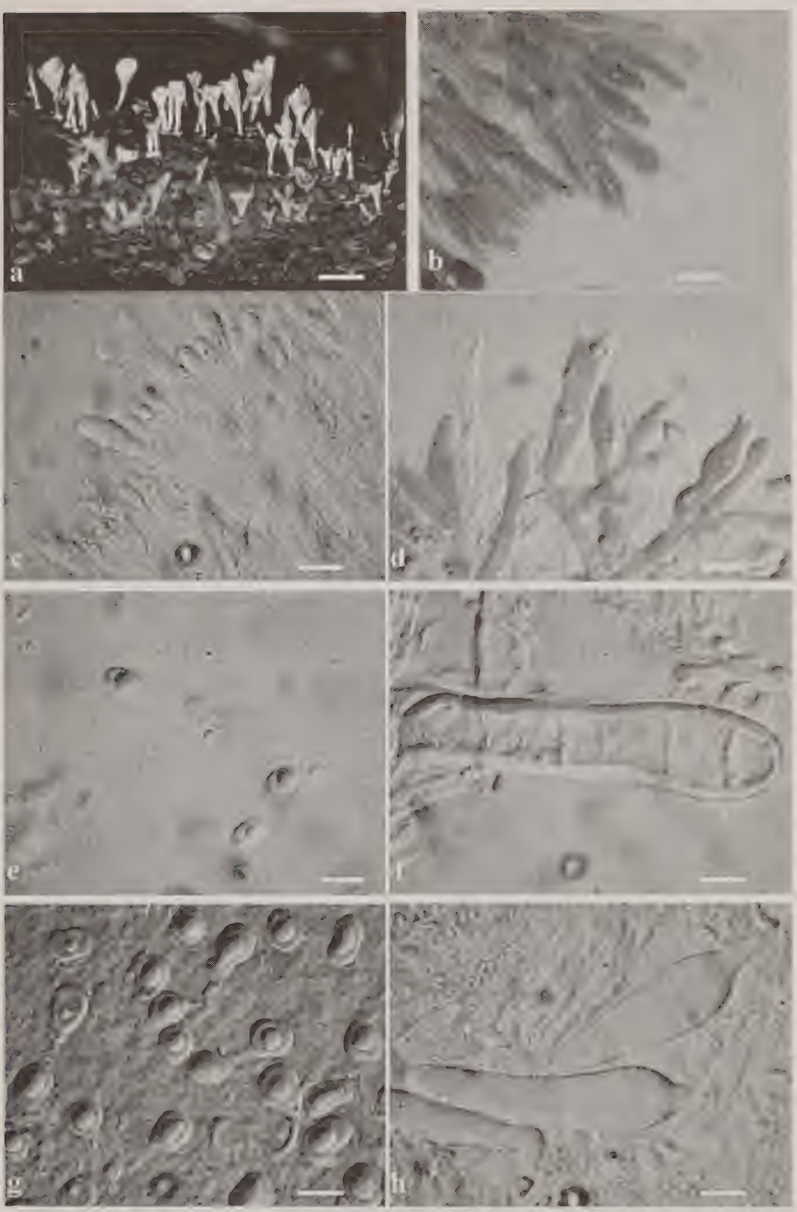
Ecology and distribution. Clustered to growing in dense colonies on dead wood of undetermined tree in the semi-deciduous forest with *Sterculiaceae* and *Ulmaceae*. Hitherto only known from the Mbalmayo forest reserve, Cameroon.

SPECIMEN EXAMINED — **CAMEROON. CENTRE PROVINCE**, **Dept. Nyong & So'o**, MFR-Oyack II, 47 km South east of Yaounde, 11° 54´ E, 3° 58´ N, 500-650 m asl., 9.X.2002, C. Douanla-Meli, DMC 232, **HOLOTYPE**-HUYI, ISOTYPE-O.

COMMENTS — *P. disseminata* is characterised and distinguished in having smaller basidiomata, infundibuliform, flabellate to setiform, truly stipitate, pileus surface smooth, basidia 1 to 2-spored, hyphal system dimitic, pileocystidia and caulocystidia present, chlamydospores abundant in all tissues. These features support its position in *Podoscypha*. *P. disseminata* is closest to *P. brasiliensis* D.A. Reid that occurs in Brazil. The basidiomata of both taxa are smaller, lignicolous, growing gregarious and truly infundibuliform to flabellate. According to Reid (1965), *P. brasiliensis* lacks chlamydospores, pileocystidia and caulocystidia; the almost 4-spored basidia also distinguish *P. brasiliensis* from *P. disseminata*. The new taxon is also reminiscent of another Brazilian species, *P. bubalina* D.A. Reid which has smaller basidiomata, 1-2 × 0.3-1.2 cm, truly infundibuliform. However the Brazilian species has smaller basidiospores 3.75-4.75 × (2.2-)2.5-3.2 µm, and lacks chlamydospores and pileocystidia. *P. parvula* Reid is also closely related to *P. disseminata* but may be separated from this taxon by its larger basidiomata golden-orange or orange-brown coloured, lacking chlamydospores and with smaller, (3-)3.2-4(-4.75) × 2-2.5(-3) µm, subglobose to broadly ellipsoid basidiospores.

P. disseminata belongs to the group of *Podoscypha* species with chlamydospores present in the basidiomata tissues, as *P. bolleana* and *P. venustula* (Speg.) D. A. Reid (Reid, 1965). *P. venustula* has a basidiomata up to 6 cm high and 4 cm wide, smaller basidiospores (3.2-)3.5-4.75 × 2.2-3.5(-3.75) µm, and is known only from South America and probably in New Zealand. *P. disseminata* is related to the African *P. bolleana* common in Cameroon. The latter has normally 2-5 cm high basidiomata and may reach 7 cm, can occur in large clusters with many basidiomata fused along their margins. The pileus is glabrous, often ornamented with densely crowded, short, radiating wrinkles which give the surface a lineate-striate effect (Reid 1965). Basidiospores varies from 4.8-5.5(-6) × (3.2-)3.8-4.5 µm (Boidin, 1961), (3.75-)4-5(-6) × (2.2-)2.75-3.2(-4) µm (Reid, 1965). In *P. disseminata*, basidiospores are slightly larger than those of *P. bolleana*, while the pileocystidia and caulocystidia have frequent transverse septa. Furthermore, *P. bolleana* differs from *P. disseminata* in possessing 4-spored basidia. *P. disseminata* differs especially in having 1 to 2-spored basidia, with longer sterigmata; these features in combination with the smaller basidiomata make it a unique species in the genus *Podoscypha*.

Plate 1. — ***Podoscypha disseminata*** (Holotype DMC 232-HUYI). a. Basidiomata clustered on dead wood. b-h. Microfeatures under light microscope. b-d. Basidia 1-2-spored. e. Basidiospores. f. Caulocystidia. g. Chlamydospores. h. Gloeocystidia. Scale bar represents 1 cm for a, and 10 µm for b-h.


a
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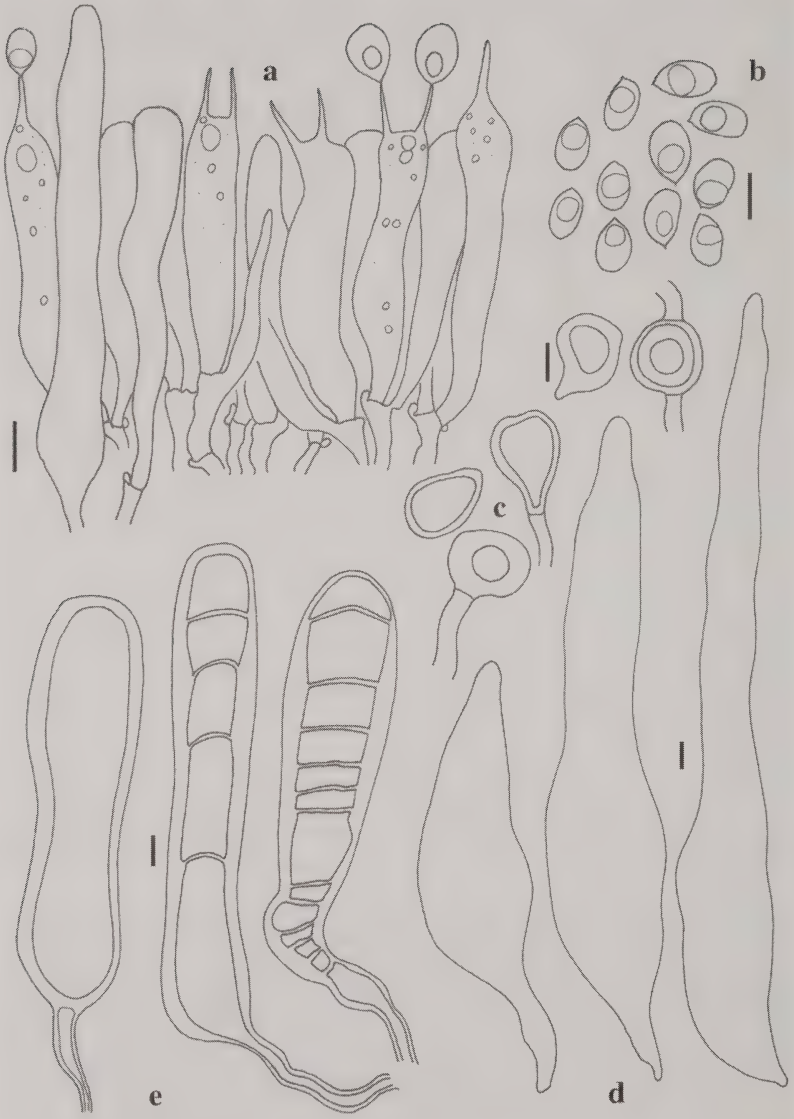

Fig. 1 — ***Podoscypha disseminata*** (Holotype DMC 232-HUYI). Line drawings. a. Section in the hymenium showing 1-2-spored basidia and intermingled gloeocystidia. b. Basidiospores. c. Chlamydospores. d. Gloeocystidia. e. Pileo- and caulocystidia. Scale bar represents 5 μm.

Taxa recorded

Cymatoderma dendriticum (Pers.) D.A. Reid in Kew Bull. 13: 523, 1958 (1959).
= *Cladoceris dendritica* (Pers) Berk. in Hook. London Journ. Bot., I, p. 152 (1842)

A pantropical species, very common in Cameroon, was first reported from Cameroon by Hennings (1895), later from Douala by Berthet & Boidin (1966), from Korup National Park (Hjortstam & al., 1999; Roberts, 2000).

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MFR-Oyack II, 47 km South east of Yaounde, 11° 54´ E, 3° 58´ N, 500-650 m asl., on dead wood of *Pinus khasia* (Coniferous), 25.IX.2002, C. Douanla-Meli, DMC 209 (HUYI).
ADDITIONAL SPECIEMEN EXAMINED — DEMOCRATIC REPUBLIC OF CONGO, PROV. MBANDA, **Eala**, N 00°03' E 18°19´, IV.1923, Goossens-Fontana (BR-Myc 034162, 18).

Cymatoderma elegans Jungh. in Tijdschr. Nat. Gesch. 7: 290, 1840.
= *Cymatoderma elegans* var. *spongiosum* (Fr.) Boidin in Bull. Jard. Bot. Brux. **30**: 296, 1960.

A very common species in tropical Africa and Asia.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MFR-Bilik, 47 km South east of Yaounde, 11° 54´ E, 3° 58´ N, 500-650 m asl., on dead wood, 15.V.2001, C. Douanla-Meli, DMC 110 (HUYI).
ADDITIONAL SPECIEMEN EXAMINED — DEMOCRATIC REPUBLIC OF CONGO, **Ipamu**, S 04°07´ E 14°37´, unknown date, Vanderyst H. (BR-Myc 033916, 63).

Podoscypha bolleana (Mont.) Boidin in Bull. Jard. Bot. Brux. 30: 323, 1960.
= *Stereum bolleanum* Mont. in Syll. Crypt.: 177 (1856).

A very common species in Cameroon, it was reported from Bipindi, Southern Cameroon, Douala (Boidin, 1961, 1966; Reid, 1965, Berthelet & Boidin, 1966), Korup National Park (Hjortstam & al., 1999; Roberts 2000). A conspicuous species in the Mbalmayo forest reserve on fallen logs and branches.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MFR-Ekombitie, 11° 54´ E, 3° 58´ N), 500-650 m asl., on dead wood, 15 V 2001, C. Douanla-Meli, DMC 222 (HUYI); MBR-Oyack II, on dead wood, 20.IX.2002, C. Douanla-Meli, DMC 229 (HUYI); 21.IX.2002, C. Douanla-Meli, DMC 228 (HUYI); 21.IX.2002, C. Douanla-Meli, DMC 230 (HUYI); on dead wood of *Diospyros crassiflora* (*Ebenaceae*), 09.X.2002, C. Douanla-Meli, DMC 231 (HUYI).
ADDITIONAL SPECIEMEN EXAMINED — DEMOCRATIC REPUBLIC OF CONGO, PROV. KIVU, **Kinawa**, N 00°40´ E 29°50´, 13.IX.1953, De Witte G. F. 9598 bis (BR-Myc 034267, 26).

Podoscypha involuta (Klotzsch apud Fr.) Imazeki in Bull. Govt Forest Exp. Stn. Meguro 57: 98, 1952.
= *Stereum involutum* Kl. in Apud. Fr., Epicr. 546. 1836

A species abundant in tropics. Previously recorded from Cameroon by Hennings (1895), Boidin (1960), known in Tiko, Bembia, Limbe, Buea (Reid, 1965), in Korup National Park (Hjortstam & al., 1999; Roberts 2000).

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MBR-Ekombitie, 47 km South east of Yaounde, 11° 54´ E, 3° 58´ N, 500-650 m asl., on dead wood, 15.V.2001, C. Douanla-Meli, DMC 214 (HUYI); MBR-Oyack II, 20.IX.2002,

C. Douanla-Meli DMC 215 (HUYI); 24.IX.2002, C. Douanla-Meli, DMC 216 (HUYI); on dead wood of *Khaya ivorensis*, C. Douanla-Meli, DMC 220 (HUYI), DMC 217 (HUYI); on dead wood of *Triplochiton scleroxylon*, 24.IX.2002, C. Douanla-Meli, DMC 218 (HUYI); 03.X.2002, C. Douanla-Meli, DMC 219 (HUYI).

ADDITIONAL SPECIEMEN EXAMINED — DEMOCRATIC REPUBLIC OF CONGO, **Eala**, N 00°03´ E 18°19´, IV.1923, Goossens-Fontana (BR-Myc 034320, 79).

**Podoscypha nitidula* (Berk.) Pat. in Duss, Énumération Méthodique des champignons recueillies à la Guadeloupe et à la Martinique (Lons-le-Saunier): 21, 1903.

A species originally described from Brazil, common in South America (Reid, 1965), previously recorded from Cameroon by Berthelet & Boidin (1966) in Douala.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, **Dept. Nyong & So'o**, MBR-Oyack II, 47 km South east of Yaounde, 11° 54´ E, 3° 58´ N, 500-650 m asl., on the ground, 25.IX.2002, C. Douanla-Meli, DMC 224 (HUYI).

ADDITIONAL SPECIEMEN EXAMINED — BURUNDI, PROV. BURUNDI, Siguvyaye ten W van de weg Mutambara-Burundi, S 03°58´ E 29°37´, 02.II.1979, Rameloo J. 6478 (BR-Myc 034362, 24).

Podoscypha parvula (Lloyd) D. A. Reid in Beih. Nov. Hedwigia 18: 298, 1965.

Apparently not common as *P. bolleana* but equally widespread. Known from Cameroon in Mt. Cameroon area (Reid, 1965), recorded in Douala by Boidin & Lanquetin (1973), in Korup National Park by Roberts (2000).

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, **Dept. Nyong & So'o**, MBR-Ekombitie, 47 km South east of Yaounde, 11° 54´ E, 3° 58´ N, 500-650 m asl., on dead wood, 29.VIII.2003, C. Douanla-Meli, DMC 226 (HUYI).

ADDITIONAL SPECIEMEN EXAMINED — DEMOCRATIC REPUBLIC OF CONGO, **Kabamba**, S 06°46´ E 23°23´, Lac Tanganyka, 1967, Van Meel L. 66 (BR-Myc. 034370, 32).

**Podoscypha petalodes* subsp. *rosulata* D. A. Reid in Beih. Nov. Hedwigia 18: 298, 1965.

Rather widespread in tropics and subtropics.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, **Dept. Nyong & So'o**, MBR-Ekombitie, 47 km South east of Yaounde, 11° 54´ E, 3° 58´ N, 500-650 m asl., growing on the ground and buried dead wood, 29.VIII.2003, C. Douanla-Meli, DMC 225 (HUYI).

ADDITIONAL SPECIEMEN EXAMINED — DEMOCRATIC REPUBLIC OF CONGO, PROV. KIVU, **Panzi**, S 02°33´ E 28°52´, I.1955, on dead wood, Goossens-Fontana 5432 (BR-Myc. 034388, 50).

**Podoscypha simulans* (D. A. Reid) Sheng H. Wu in Mycotaxon 88: 373-376, 2003
= *Podoscypha fulvo-nitens* var. *simulans* (Berk.) D. A. Reid in Beih. Nov. Hedwigia 18: 298, 1965.

A pantropical species.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, **Dept. Nyong & So'o**, MBR-Ekombitie, 47 km South east of Yaounde, 11° 54´ E, 3° 58´ N, 500-650 m asl., on dead wood, 17.V.2001, C. Douanla-Meli, DMC 223 (HUYI).

ADDITIONAL SPECIEMEN EXAMINED — DEMOCRATIC REPUBLIC OF CONGO, PROV KIPUSHI, Loc.: **Tumbwe** — S 11°26´ E 27°20´, Van Meel L. 549, 06.I.1947 (BR-Myc. 034299, 58).

Podoscypha thozetii (Berk.) Boidin in Rev. Mycol., Paris 24: 208, 1959.

A common species in tropical Africa, widespread in the Mbalmayo forest reserve.

SPECIMEN EXAMINED — CAMEROON. **CENTRE PROVINCE**, **Dept. Nyong & So'o**, MBF-Oyack II, 47 km South east of Yaounde, 11° 54´ E, 3° 58´ N, 500-650 m asl., on the ground, 20.X.2002, C. Douanla-Meli, DMC 227 (HUYI).

ADDITIONAL SPECIEMEN EXAMINED — BURUNDI, **Kanyinga**, site Lac Rwihinda, between grass, 09.XII.1967, Petit E. 1980 (BR-Myc 034390, 52).

Podoscypha vespillonea (Berk.) Boidin & Lanq. in Persoonia, vol. 7, 2: 141-150, 1973.

A common species in central Africa, widespread in Cameroon, Douala, Edéa, Japoma and the littoral area (Boidin & Lanquetin, 1973), common as *P. involuta* in the Mbalmayo forest reserve.

SPECIMEN EXAMINED — CAMEROON. **CENTRE PROVINCE**, **Dept. Nyong & So'o**, Mbalmayo forest reserve, Oyack II, 47 km South east of Yaounde (11° 54´ E, 3° 58´ N), 500-650 m asl., on dead wood, 20.X.2002, leg. C. Douanla-Meli, DMC 220-HUYI.

Podoscypha warneckeana (Henn.) Ryvarden in Mycotaxon 64: 401-403, 1997.
= *Podoscypha nitidula* var. *warneckeana* (Henn.) D. A. Reid in Beih. Nov. Hedwigia **18**: 298, 1965.

A common species in tropical Africa and Asia constantly associated with grass (*Gramineae*). Previously recorded in Douala and surrounding area by Berthet & Boidin (1966).

SPECIMEN EXAMINED — CAMEROON. **CENTRE PROVINCE**, **Dept. Nyong & So'o**, MBR-Oyack II, 47 km South east of Yaounde, 11° 54´ E, 3° 58´ N, 500-650 m asl., on the ground colonized by the Gramineae (*Pennisetum purpureum* Schumach.) along roadside, 25.X.2002, C. Douanla-Meli, DMC 223 (HUYI).

ADDITIONAL SPECIEMEN EXAMINED — DEMOCRATIC REPUBLIC OF CONGO, **Angidia**, N 03°32´ E 25°47´, V.1931, Lebrun J. 2943 (BR-Myc. 034366, 28).

Stereopsis hiscens (Berk. & Ravenel.) D. A. Reid in Beih. Nov. Hedwigia 18: 298, 1965.

A common species in tropics and subtropics. It was previously reported from Cameroon by Reid (1965), also known from Douala (Berthelet & Boidin, 1966).

SPECIMEN EXAMINED — CAMEROON. **CENTRE PROVINCE**, **Dept. Nyong & So'o**, MBR-Ekombitie, 47 km South east of Yaounde, 11° 54´ E, 3° 58´ N, 500-650 m asl., on the ground, 16.X.2002, C. Douanla-Meli, DMC 234 (HUYI).

**Stereopsis hiscens* f. *rosea* D. A. Reid in Beih. Nov. Hedwigia 18: 298, 1965.
A form previously known only from Malaya (Reid, 1965). A single collection on dead wood.

SPECIMEN EXAMINED — CAMEROON. **CENTRE PROVINCE**, **Dept. Nyong & So'o**, MBR-Ekombitie, 47 km South east of Yaounde, 11° 54´ E, 3° 58´ N, 500-650 m asl., on the ground, 09.X.2002, C. Douanla-Meli, DMC 236 (HUYI).

**Stereopsis radicans* D. A. Reid in Beih. Nov. Hedwigia 18: 298, 1965.

A common species throughout the tropics and subtropics. Boidin (1966) doubtfully included Cameroon in the distribution area of this species in Central Africa; still no further data for confirmation as Reid (1965) did not examine or mention collections from Cameroon. This specimen is herein presented as new to Cameroon.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MBR-Oyack II, 47 km South east of Yaounde, 11° 54´ E, 3° 58´ N, 500-650 m asl., on the ground arising from buried dead wood, 14.VIII.2003, C. Douanla-Meli, DMC 233 (HUYI).

Key to *Podoscyphaceae* genera in Cameroon

1. Hyphal system monomitic, hyphae densely compact, thin to thick-walled, with or without clamps, basidiospores subglobose, cystidia absent.................***Stereopsis***
1. Hyphal system dimitic or trimitic with generative hyphae and thick-walled skeletal hyphae, gloeocystidia present and abundant...2
    2. Basidiomata much broad, hymenium warty or ridged, stipe stout, hirsute or tomentose, sterile surface tomentose................................ .***Cymatoderma***
    2. Basidiomata usually smaller, often thin and translucent with smooth hymenial surface, sterile surface almost glabrous.............................. ***Podoscypha***

Key to species of *Cymatoderma* in Cameroon

1. Thick-walled cystidia present, hymenium white ornamented, ridged, warty to verrucose, tomentum more or less abundant, sterile surface more colored ....***C. elegans***
1. Thick-walled cystidia absent...2
    2. Basidiomata stipitate, arising from a large sclerotium, hymenium coarsely veined..***C. africanum***
    2. Basidiomata dimidiate, sessile to shortly stipitate, hymenium paler than the upper surface...3
        3. Pileus surface tomentose, beige to fawn coloured, hymenium surface with densely crowded, rather sharp, radiating branched ribs, basidiospores 3-5 × 2.8-4.8 μm; chlamydospores absent..................................***C. dendriticum***
        3. Basidiomata tomentose, dimidiate, spores 5-6 × 3.8-4.5 μm, chlamydospores present in the context.. ***C. pallens***

Key to species of *Podoscypha* in Cameroon

1. Thick-walled cystidia present in the hymenium...2
    2. Pileus glabrous, often zonate, distinctly stipitate, hymenial surface covered with a whitish or greyish pruina.. ***P. mellisii***
    2. Pileus tomentose...3
        3. Basidiomata mostly attached by a broad, flattened stipe-like base, spathulate, flabellate or reniform, seldom infundibuliform, upper surface light-brown, dark-brown, orange-brown, either uniformly coloured or with narrow zones of various shades.. ***P. involuta***

3. Basidiomata sessile to distinctly stipitate, flabellate, with fused margins to infundibuliform, upper surface ornamented with concentric zones alternately brown to dark-brown………………..………….. ***P. vespillonea***

1. Thick-walled cystidia absent in the hymenium…………...……….....………… 4
    4. Basidiomata growing on dead wood……………………………….………. 5
        5. Chlamydospores present……………………………………………………. 6
            6. Basidiomata usually forming clusters of variously fused pilei or occur as discrete basidiomata, basidia 4-spored………………..… ***P. bolleana***
            6. Basidiomata smaller 1-2 cm high and 0.5-1.5 cm wide, clusters of discrete basidiomata, infundibuliform, truly stipitate, basidia almost 1-2 spored………………...…………………....***P. disseminata*** nov. sp.
        5. Chlamydospores absent……………………………………………………..7
            7. Basidiomata bearing a dense tangled mat of fibrillose processes which may arise almost anywhere over the surface of the pileus ……...………………………………………………...……… ***P. ursina***
            7. Surface of the pileus glabrous, lacking all trace of hairs, or antler-like processes visible to the naked eye…....……………………………….8
                8. Basidiomata, flabellate to spathulate, golden-orange or brown-orange on dry, polymorphic, attached by a conspicuous disc of mycelium, basidiospores (3-)3.2-4(-4.75) × 2-2.5(-3) μm, ……….. …………………….…………………………..………. ***P. parvula***
                8. Basidiomata usually infundibuliform, attached by a conspicuous basal disc of mycelium, caulocystidia absent, basidiospores (3-)3.75-4.5-6 × 2-3 μm ……...……………………….. ***P. simulans***
    4. Basidiomata terrestrial or growing on buried dead wood……………...…..9
        9. Basidiospores large 6-10 × 4-6 μm, basidiomata truly infundibuliform, pale-buff with conspicuous rusty-brown zones when dried ……..………………………...…………………………..….... ***P. thozetii***
        9. Basidiospores not as above, basidiomata forming dense rosettes or discrete, at times crowded together and fused...………………………...… 10
            10. Basidiomata normally forming dense rosettes but occasionally occurring as discrete, of virtually any shape, basidiospores 3,5-6 × 2.5-4 μm……...……………….…… ***P. petalodes*** subsp. ***rosulata***
            10. Basidiomata usually infundibuliform, rarely flabellate...……… 11
                11. Pileus surface glabrous stipe often bearing a few scattered caulocystidia, basidiospores 3.5-6(6.5) × 3-4(-5) μm ……...………………………..……………………...…… ***P. nitidula***
                11. Basidiomata always associated with roots or dead culms of grasses (Gramineae), basidiospores 4-6(6.2) × 3-4(-5) μm, subglobose to broadly elliptical……..………………...…… ***P. warneckeana***

Key to species of *Stereopsis* in Cameroon

1. Clamps connections present………………………………………………….…2
    2. Gloeocystidia present, basidiomata solitary to gregarious, pileus white at first then pale cream, basidiospores subglobose, basidia 2-spored, pantropical…… ……..…………………………...……………...……………..***S. radicans***

2. Gloeocystidia absent……………………………………………………………3
    3. Basidiomata discrete or forming a large complicated rosette or cauliflower-like fructifications, pileus whitish to grayish white, smooth or minutely appressed silky-fibrillose, basidiospores subglobulose with prominent, oblique apiculus, 6-8.5(-8.5) × 6-7.5 μm………………………***S. hiscens***
    3. Basidiomata rosette-like, pileus pinkish to brownish, pale brown when dry, radiately fibrillose, basidiospores 6.5-8.5 × 5.5-8 μm, globose, subglobose, to broadly elliptical, almost largely apiculate…………………………………………………………………***S. hiscens*** var. ***rosea***

1. Clamps connections absent, basidiomata white to pale ochraceous on fresh, and drying pinkish buff to buff, hymenial surface cream to pale, drying ochraceous-buff, basidiospores (4.5-)5-7.5 × (3.75-)4-6 μm…………………………***S. cartilaginea***

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The authors are thankful to the curator of herbarium BR for loaning other African specimens of *Podoscypha* and *Cymatoderma*. Furthermore, Mr. Robert Zambo is thanked for facilitating fieldwork. We are obliged to Prof. Ryvarden and Dr. Hjortstam for critically reviewing and improving the earlier manuscript. This research was financially supported by the grant A/01/20502 from the German Academic Exchange Service (DAAD) to the senior author.

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Two new species of *Imshaugia* (Ascomycota: *Parmeliaceae*) from South America

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Abstract—*Imshaugia pyxiniformis and I. sipmanii* are described as new to science. Both species are characterized by small subglobose to ellipsoidal ascospores, *Psora*-type conidiophores, short, ampulliform or bifusiform conidia and the presence of cortical lichexanthone and medullary protocetraric acid. In addition, the new combinations *Imshaugia subarida, I. venezolana* and *Parmeliopsis macrospora* are made.

Key words— lichens, taxonomy

Introduction

The small genus *Imshaugia* S.L.F. Meyer was segregated from *Parmeliopsis* (Nyl.) Nyl. in the 1980s (Meyer 1982, 1985). These two genera are distinguished from most other parmelioid genera by the *Psora*-type conidiophores (Type II, Vobis 1980). Meyer segregated *Imshaugia* on the basis of its emergent and partly marginal pycnidia (immersed and laminal in *Parmeliopsis*), its short, ellipsoidal to subglobose ascospores (long and kidney-shaped in *Parmeliopsis*) and its short, ampulliform or bifusiform conidia (long and curved in *Parmeliopsis*). *Imshaugia* is also distinguished from that genus by the fungal cell walls containing *Cetraria*-type lichenan rather than isolichenan. During an investigation of various parmelioid lichens from South America two new species of *Imshaugia* were discovered and form the subject of this paper.

Materials and Methods

The morphology of the lichen specimens were examined using a Zeiss Stemi 2000C stereo microscope, and a Zeiss Axiolab compound microscope. Chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson et al. 1981; Culberson & Johnson 1982; Elix & Ernst-Russell 1993), high performance liquid chromatography (Elix et al. 2003) and comparison with authentic samples.

Taxonomic Descriptions

Imshaugia pyxiniformis Elix, *sp. nov.* FIGURE **1A**

Thallus ut in Imshaugia placorhodia sed lobis sublineariter vel sublineariter-elongatis, apotheciis angustioribus et lichexanthonum, acidum 4-O-demethylmicrophyllinicum et acidum protocetraricum continente differt.

Etymology: a consequence of the superficial resemblance of this species to various *Pyxine* species.

Type: **BRAZIL**. Pará: Serra do Cachimbo, 888 km N of Cuiabá on Cuiabá-Santarém highway (BR-163), c. 8°45'S, 54°57'W, 350-500 m, on bark in dry vegetation on top of N-S ridge in tall canopy forest on W side of steep slope, *L. Brako & M. J. Dibben 6700,* 4 May 1983; holo: NY.

KEY CHARACTERS — **Thallus** corticolous, foliose, adnate, 3-4 cm wide. **Lobes** contiguous to sparingly imbricate, separate at apices, sublinear to sublinear-elongate, dichotomously to subdichotomously branched, 0.8-1.5 mm wide, eciliate, apices incised. **Upper surface** yellow-gray, flat to weakly convex, emaculate, shiny at apices but dull within, smooth; isidia and soredia absent. **Medulla** white. **Lower surface** ivory to pale brown, ± rugulose; rhizines dense, simple, pale brown to brown, to 1 mm long. **Apothecia** sessile, 0.5-1.2 mm wide; disc flat to weakly concave, dark brown, thalline exciple smooth. **Ascospores** colourless, 8 per ascus, subglobose to broadly ellipsoidal, 7-8 x 5-7 μm. **Pycnidia** common, laminal and marginal, emergent. **Conidia** terminal on conidiophores, ampulliform to weakly bifusiform, 5-7 x 1 μm. **Chemistry** — CORTEX K-, UV+ INTENSE YELLOW; MEDULLA K+ PALE YELLOW-BROWN, C+ RED, KC+ RED, P+ ORANGE-RED; CONTAINING LICHEXANTHONE (MINOR), PROTOCETRARIC ACID (MINOR), 4-*O*-demethylmicrophyllinic acid (major).

Distribution — At present this species is only known from the type collection.

COMMENTS — THIS NEW SPECIES IS CHARACTERIZED BY THE NARROW, SUBLINEAR TO SUBLINEAR-ELONGATE, ECILIATE LOBES, THE LACK OF VEGETATIVE PROPAGULES, THE PALE LOWER CORTEX, VERY DENSE, SIMPLE RHIZINES AND THE PRESENCE OF LICHEXANTHONE IN THE UPPER CORTEX (UV+ INTENSE YELLOW) AND 4-*O*-demethylmicrophyllinic and protocetraric acids in the medulla. Superficially *I. pyxiniformis* closely resembles some species of *Pyxine* (e.g. *P. petricola* Nyl. ex Cromb.) with narrow, contiguous lobes, UV+ yellow upper surface and small, sessile apothecia. However, *I. pyxiniformis* can be readily distinguished by the dark brown discs (black in *Pyxine*), the simple, colourless ascospores (brown and 1-septate in *Pyxine*) and the pale lower surface (black in *Pyxine*). Like *I. pyxiniformis, P. placorodia* (Ach.) S.L.F. Meyer lacks vegetative propagules but can readily be distinguished by the much wider apothecia (1.5-12 mm wide) with dentate margins, the subirregular lobes and the presence of cortical atranorin and chloroatranorin (UV-) and medullary thamnolic acid.

Imshaugia sipmanii Elix, *sp. nov.* FIGURE **1B**

Thallus ut in Imshaugia pyxiniformis sed saxicola, apotheciis substipitatus et acidum 4-O-demethylmicrophyllinicum noncontinente differt.

Etymology: in honour of the collector, renowned Dutch lichenologist Dr Harrie Sipman.

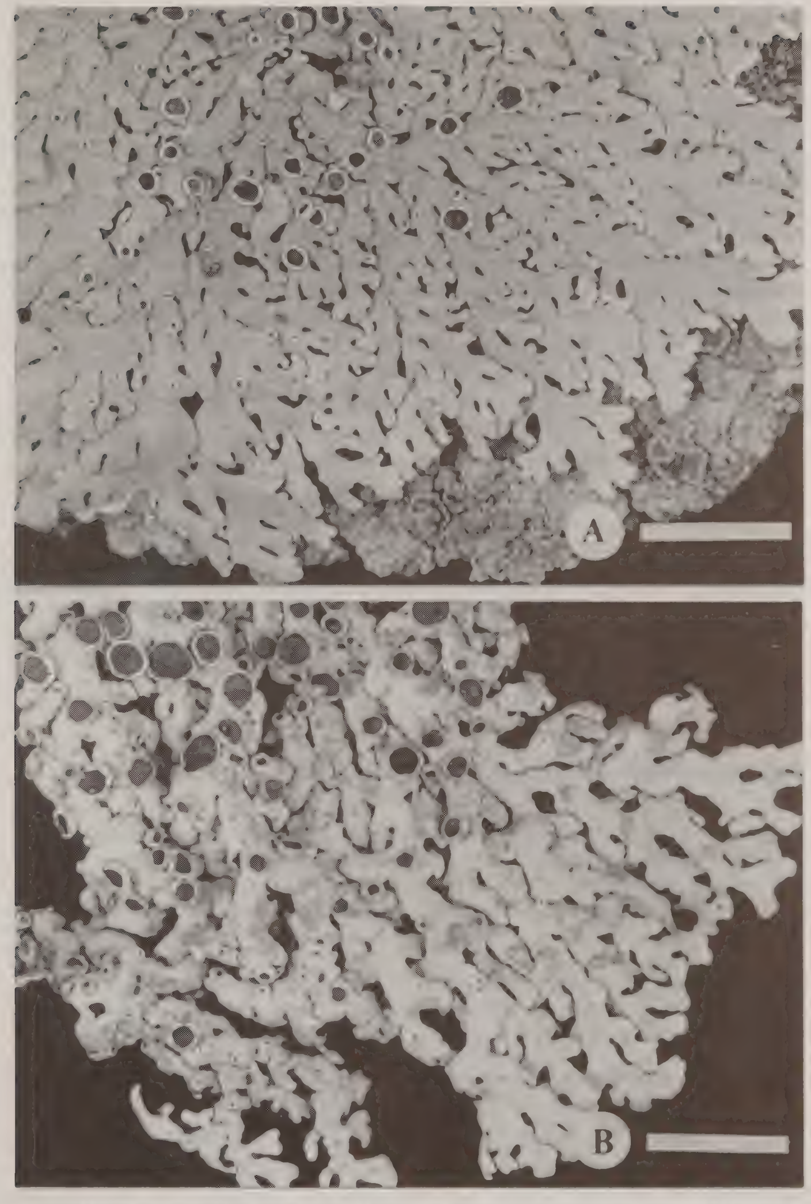

Fig. 1. A. *Imshaugia pyxiniformis* (holotype in NY). B. *Imshaugia sipmanii* (holotype in B). Scale bar = 5.0 mm.

Type: **VENEZUELA**. Estado Bolivar: Cerro Guaiquinima, near NE edge of upper plateau (near camp 2), c. 5°54’N, 63°27’W, 1200 m, on rock in rocky sandstone area with scattered scrub, *H. Sipman 26705,* 7 February 1990; holo: B.

KEY CHARACTERS — **Thallus** saxicolous, foliose, loosely adnate, 3-5 cm wide. **Lobes** contiguous to sparingly imbricate, separate at apices, sublinear to sublinear-elongate, dichotomously branched, 0.8-1.2 mm wide, eciliate, apices incised. **Upper surface** whitish-gray, flat to convex, emaculate, shiny at apices but dull within, smooth to rugulose; isidia and soredia absent. **Medulla** white. **Lower surface** ivory to pale brown, blackening at tips, ± rugulose; rhizines dense, simple, pale brown to brown, to 1 mm long. **Apothecia** substipitate, 0.8-1.5 mm wide; disc flat to weakly concave, dark brown to black, thalline exciple smooth, eventually roughened and pynidiate. **Ascospores** colourless, 8 per ascus, subglobose to broadly ellipsoidal, 7-8 x 6-7 μm. **Pycnidia** common, laminal and marginal, emergent. **Conidia** terminal on conidiophores, bifusiform, 6-8 x 1 μm. **Chemistry** — Cortex K-, UV+ yellow; medulla K+ pale yellow-brown, C-, KC-, P+ orange-red; containing lichexanthone (major), protocetraric acid (major), virensic acid (trace).

Distribution — At present this species is only known from the type collection.

COMMENTS — *Imshaugia sipmanii* closely resembles *I. pyxiniformis,* described above, but differs from that species in being saxicolous rather than corticolous, in having a much more loosely adnate thallus, substipitate apothecia, distinctly bifusiform conidia and in lacking 4-*O*-demethylmicrophyllinic acid in the medulla. These are the only species of *Imshaugia* known to contain lichexanthone rather than atranorin and chloroatranorin in the upper cortex. However, other parmelioid genera (e.g. *Hypotrachyna*) have representative species showing analogous variations in cortical chemistry.

New Combinations

Imshaugia subarida (Elix) Elix, comb. nov.

BASIONYM — *Canoparmelia subarida* Elix, *Mycotaxon* **47**: 103 (1993).

SPECIMENS EXAMINED — **AUSTRALIA. South Australia**: North-Western Region, 20 km W of Vokes Corner, 28°34’S, 130°29’E, on bark of *Acacia aneura, N. N. Donner 7376,* 23 August 1980 (AD). **Western Australia**: Nookaminne Picnic Area, 4 km W of Quairading, 32°01’19”S, 117°22’19”E, 250 m, on dead twigs of *Casuarina, J. A. Elix 31794, 31796, 31798*, 22 April 2004 (CANB).

Imshaugia venezolana (Hale) Elix, comb. nov.

BASIONYM — *Pseudoparmelia venezolana* Hale, *Smithsonian Contr. Bot.* **31**: 55 (1993).

SPECIMEN EXAMINED — **VENEZUELA. Estado Táchira**: Pico Banderas, Páramo de Tamá, 3000-3300 m, exposed rocky paramo, *M. E. Hale 45499a & M. Lopez Figueiras*, 27 March 1975 (CANB, US).

COMMENTS — An examination of representative specimens of the two species above has established that both exhibit emergent pycnidia with *Psora*-type conidiophores and short, ampulliform or weakly bifusiform conidia typical of *Imshaugia.*

Parmeliopsis macrospora (Elix & J.Johnst.) Elix, comb. nov.

BASIONYM — *Canoparmelia macrospora* Elix & J.Johnst., *Mycotaxon* **31**: 491 (1988).

SPECIMENS EXAMINED — **AUSTRALIA. Western Australia**: On trail to The Loop, Kalbarri National Park, 27°33'S, 114°27'E, on dead stump, *H. W. Bennett s.n.*, 26 August 1996 (PERTH); 6 km NE of Mt Harry, Ninghan Station, 29°18'S, 117°33'E, on *Acacia* bark in open scrub, *R. J. Cranfield 86271*, 26 November 1992 (PERTH); Charles Gardner Flora Reserve, central track, 20 km SW of Tammin along old York Road, 31°47'24"S, 117°28'07"E, 305 m, on base of *Eucalyptus*, *J. A. Elix 31842, 31847*, 22 April 2004 (CANB); site 7, Wanjarri Nature Reserve, 27°27'S, 120°40'E, on bark, *C. S. Fang & R. J. Cranfield 220/94*, 31 August 1994 (PERTH); 4 km E of Bullabulling, 31°01'S, 120°53'E, on base of *Acacia* in open scrubland, *J. A. Elix 21728 & M. V. Sargent,* 20 August 1987 (CANB).

COMMENTS — EXAMINATION OF ADDITIONAL SPECIMENS OF THIS SPECIES HAS ESTABLISHED THAT IT HAS APOTHECIA WITH LARGE, RENIFORM ASCOSPORES (16-20 x 5-6 μM) AND IMMERSED PYCNIDIA CONTAINING *Psora*-type conidiophores and long, curved (sickle-shaped) conidia (9-11 x 1 μm) typical of *Parmeliopsis.*

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MYCOTAXON

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Conidiobolus antarcticus, a new species from continental Antarctica

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Abstract–*Conidiobolus antarcticus* sp. nov. (*Entomophthorales*: *Ancylistaceae*), was isolated from the antarctic mosses *Scistidium antarctici* and *Hennediella heimii*. It is the first record of an *Entomophthorales* species in continental Antarctica. This new fungus is distinguished from other species of the same genus in the size and shape of the primary conidia and zygospores, and in the disjunctive mycelial hyphae.

Keywords–antarctic fungi, taxonomy

Introduction

An unusual zygomycete assigned to the genus *Conidiobolus* Bref. emend. Humber (1989) has been isolated from the mosses *Scistidium antarctici* and *Hennediella heimii* in Antarctica (Tosi et al., 2002). Although this fungus is represented by a single isolate, the new taxon is sufficiently distinctive to warrant a description of a new species of the genus *Conidiobolus* which is described in this paper.

Materials and Methods

A mixed sample of the mosses *Scistidium antarctici* and *Hennediella heimii* was collected aseptically by R. Bargagli at Kohler Head (75°48'S-162°51'E) in Victoria Land, on the west coast of the Ross Sea, during the austral summer, 2 February 1999.

The sample was placed in a sterile polythene bag, stored at -20°C and processed within two months in the Mycology Laboratory at the University of Pavia. The fungus was isolated by aliquots of 0.25 g of moss broken into small pieces and placed onto the surface of agar Petri dishes containing as cultural media potato dextrose agar (PDA; DIFCO, Detroit, Michigan) and malt extract agar (MEA; DIFCO) with streptomycin

(20 ppm) and penicillin (30 ppm). Triplicate plates were incubated in the dark at 15°C and 24°C and examined daily for two weeks. Isolation and morphological studies of the fungus, modes of reproduction, assimilation of carbon and nitrogen compounds were carried out by means of techniques outlined by King (1976 a, b). Temperature-growth relationships were established at –1, 5, 10, 15, 20, 24, 30 and 45 °C.

The diameter of primary conidia was measured on water agar. Strain cultures in 60-mm Petri-dish bottom containing PDA was placed in the top of inverted plates, each containing two slide mounts with a thin film of PDA on it in order to study development of the colony. Development of the colony from primary discharged conidia was controlled each hour for the first day and then each 24 hrs for 14 days. Specimens for scanning electron microscopy (SEM) were prepared as follows: the fungus growing on PDA was fixed for 4 h in 2.5% glutaraldehyde solution in 0.1 M cacodylate buffer (pH 7.2), post-fixed for 2 h with 1% $0s0_4$, in the same buffer, dehydrated in increasing concentrations of ethanol solutions. The material was processed by the critical point drying method in a Emitech K-850 apparatus. The dried specimens were placed on a mounting base, coated with gold, and examined with a Philips XL 20 scanning electron microscope.

Taxonomic Description

Conidiobolus antarcticus Tosi, Caretta & Humber, sp. nov. (Figs 1-3)

> *Coloniae in agaro cum saccharo et tubero solani levedinis ad temperatura 20°C crescunt post 5 dies ad 42 mm diam, planae, albae. Mycelium translucens, incospicuum; hyphae septatae, 8-(10)-12 µm latae, cellulis contiguis 3-4plo ramulosis divaricate, actinodendri vel columnae vertebralis simulans. Conidiophora brevia, phototropica. Conidia primaria unitunicata, pyriformia globosa, 25-31(27.7±3)x20-25(22.8±2) µm longa, papilla prominent (5 µm), in cellulis conidiogenis apicale singulariter formantia et violenter absilientia. Conidia secondaria conidiorum primariorum conidis simulans sed parviora. Conidia primaria secondaria tubulos germinalia singulariter aliquotiesve formantia. Sporae perdurantes zygosporae vel azygosporae, globosae, 25-40 (30.2±4) µm diam, parietibus laevibus bistratibus, 2.5-5 µm crassis. Cystidia et rhizoida absentia.*
>
> *Species ex muscus Scistidium antarctici et Hennediella heimii in Antarctica ad Kohler Head (Victoria Land) sejuncta.*
>
> *Etymology:* the specific epithet refers to the locality from which the specimen was collected.

Colonies grown on PDA for 5 days at 20°C have a diameter of ca 42 mm. Mycelium colourless, inconspicuous. Hyphae septate, 8-(10)-12 µm wide. The mycelium constiuted by short segments (hyphal bodies) that develops from a single conidium. The hyphal segments contiguous, but disjointed putting forth (3-4) short diverticulate branches with an appearance like *Actinodendron* or a vertebrate skeleton's spinal column. Conidiophores short, mostly simply, positively phototropic. Conidiogenous cells undifferentiated in diameter and appearance from vegetative hyphae, with a basal septum, producing a single conidium. Primary conidia unitunicate, pyriform to globose, 25-31(27.7±3)x20-25(22.8±2) µm, with broadly rounded apex and prominent papilla (5 µm), containing numerous globules. Primary conidia forcibly discharged toward light source, germinating on PDA. Secondary conidia formed from primary conidia, slightly smaller (20%). Primary and secondary conidia producing multiple germ tubes and containing large globules. Resting spores present and numerous. Resting spores *sensu* Benny, Humber and Morton (2001) represented by zygospores and azygospores. Zygospores smooth, globose 25-40 (30.2 ±4) μm, thick-double walled (2.5-5 μm), containing one or more globules, formed between conjugating cells (gametangia) of different or the same hyphae or hyphal bodies. Azygospores, zygospore-like of the same size, with two thick wall layers (2.5-5 μm), formed without prior gametangial conjugations of the hyphae or hyphal bodies. Cystidia and rhizoids absent. Utilizes $(NH_4)_2SO_4$, glucose and trehalose. Cardinal temperatures for growth: minimum –1°C, optimum 20°C, maximum 26°C.

Holotype: CMM 1018S, slide ex CMM 1018, isolated from mosses *Scistidium antarctici* and *Hennediella heimii*, collected in Antarctica at Kohler Head (Victoria Land), deposited in the Collection of Medical Mycology of the University of Pavia. A living *ex-type* culture ARSEF 6913 (ex CMM 1018) is deposited in the USDA-ARS Collection of Entomopathogenic Fungal Cultures (Ithaca, NY).

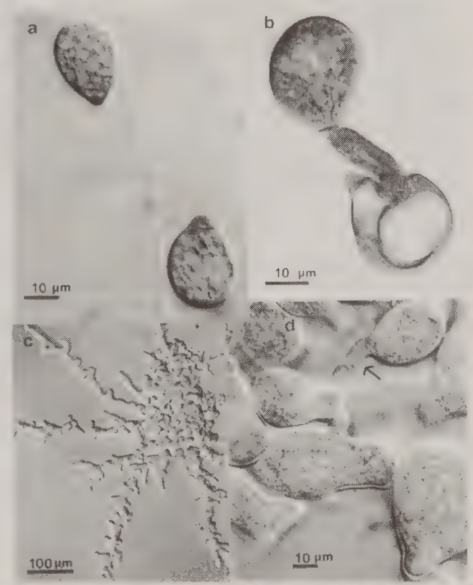

Figure 1 (top). a) Primary conidia, 1000x; b) Production of secondary conidium, 1000x; c) mycelium, 200x; d) production of conidium, the arrow indicates the basal septum, 1000x.

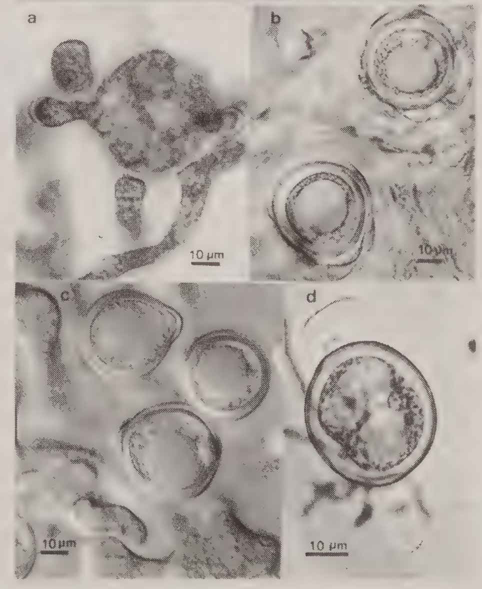

Figure 2 (bottom). a) conidium producing multipolar germ tubes, 1000x; b and c) azygospores, 1000x; d) zygospore formed between the two conjugating gametangia, 1000x.

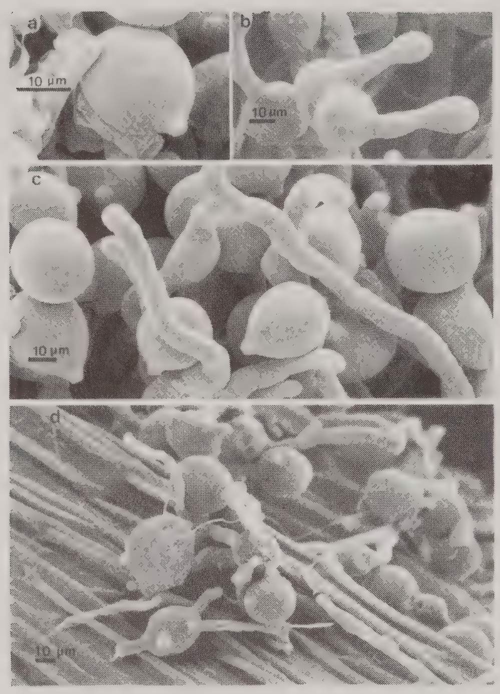

Figure 3. SEM micrographs of: a) primary conidium, 2400x; b) secondary conidia production, 800x; c) conidia and mycelial fragments, 800x; d) mycelium and conidia of the fungus growing on the moss, 540x.

To some extent, the morphological features of *Conidiobolus antarcticus* resemble those of *C. megalotocus* Drechsler, *C. thromboides* Drechsler, *C. bangalorensis* Sriniv. & Thirum. and *C. lamprauges* Drechsler. *C. antarcticus* differs from *C. megalotocus* mainly in the size and shape of the primary conidia but also in the disjunctive branching pattern of the mycelial hyphae, conidiophores *Actinodendron*-like and microconidia lacking in *C. antarcticus*. The vegetative appearance of the fungus is different from *C. thromboides*. The branching pattern is different, and the shape of the conidia is not like that in *C. thromboides*, in which the papilla is prominent and the overall shape of the conidium pyriform; the papilla of our fungus is smaller and emerges more abruptly from the overall outline of the conidium. The papilla of *C. antarcticus* also shows some greater tendency to be apiculate whereas the conidial papilla in *C. thromboides* is not apiculate. Some similarities with *C. antarcticus* are shown by *C. lamprauges* and *C. bangalorensis*. These two entomophthoraceous fungi have been listed by Srinivasan and Thirumalachar (1967) in the zygosporic species of *Conidiobolus*. The size and shape of the zygospores were the important characters for the differentiation of these species. In *C. antarcticus* the zygospores are formed through union of gametangia and the resting spores (variously called chlamydospores or azygospores) are globose measuring 25 to 30 μm. The zygospores of *C. bangalorensis* are globose and 12-18 μm diam, and those of *C. lamprauges* are also usually 12 to 18 μm in diam.

Conidiobolus antarcticus is the first species of *Entomophthorales* recorded from continental Antarctica. Bridge and Worland (2004) recently collected an unidentified species of *Neozygites* from mites, *Alaskozetes antarcticus (Acarina: Oribatidae)*, on Nelson Island off the northwestern tip of the Antarctic Peninsula. The particular climate and the geographically isolated habitat in which the Antarctic strain of *Conidiobolus* lives make this fungus different from all known similar species. This is supported by the fact that there is a high degree of endemism among *Conidiobolus* in the few parts of the world that have been studied at all intensely for the flora of this entomophthoralean genus, particularly by Drechsler (1953) in U.S.A. and Srinivasan & Thirumalachar in India (1961, 1962a, 1962b, 1965, 1968).

Acknowledgments

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A new species,
Massarina magniarundinacea

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Abstract—*Massarina magniarundinacea*, a new pleosporalean fungus, is described and illustrated. It is found on a submerged herbaceous stem from a river in Hokkaido, northern Japan. The shape of ascospores is very similar to that of *M. arundinacea*, but the dimensions are much larger, 67–82 × 6.5–9 μm (vs. 23–40 × 3.5–6 μm in *M. arundinacea*). In artificial media, *M. magniarundinacea* produces a teleomorphic state.

Key words—Ascomycetes, freshwater, *Lophiostoma*, *Pleosporales*, taxonomy

Introduction

During an investigation of freshwater ascomycetes in northern Japan, an interesting pleosporalean fungus was encountered. It was collected from an unknown herbaceous stem submerged in a river, along with another ascomycete, *Massarina arundinacea* (Sowerby: Fr.) Leuchtm. The cylindrical ascospores in the collected fungus resembled those of *M. arundinacea*, but the dimensions of ascospores were almost twice as large as those of the latter. Therefore, we describe the fungus as a new species, *M. magniarundinacea*. Methods of microscopic observation, single ascospore isolation, and cultivation followed Tanaka and Harada (2003a).

Taxonomic Description

Massarina magniarundinacea Kaz. Tanaka & Y. Harada, sp. nov.

FIGURES **1–14, 15A**

Ascomata 150–280 μm alta, 310–410 μm diametro, dispersa, erumpentia, subglobosa, basi plana, in latere hyphis sparsis brunneis vestita. Rostrum centrale, breve, aliquantum papillatum, ex cellulis brunneis globosis 2–4 μm diametro compositum. Paries ascomatis in latere 12.5–20 μm crassus, ex cellulis 4–5-stratis polygonis 3–18 × 2–4.5 μm compositus, ad basim 5–7.5 μm crassus et parum evolvens. Pseudoparaphyses copiosae, cellulosae, 1.5–3.5

μm crassus, ramificantes, per spatial 5–17 μm longa septatae. Asci (119–) 125–182.5 (–200) × 25–35 (–47.5) μm, fissitunicati, anguste ovati, apice rotundati, stipitati, octospori. Ascosporae tri- vel tetraseriatae, 67–82 × 6.5–9 μm, cylindricae vel anguste fusiformes, fere curvatae, 1–2-septatae, valde constrictae ad septum primum submedianum (0.52–0.57), infirme constrictae ad medium hemisphaerii superioris, cum septo alio in hemisphaerio inferiore formantes, hyalinae vel pallide olivaceae, laeves, guttulatae, tunica gelatinosa circumdantes.

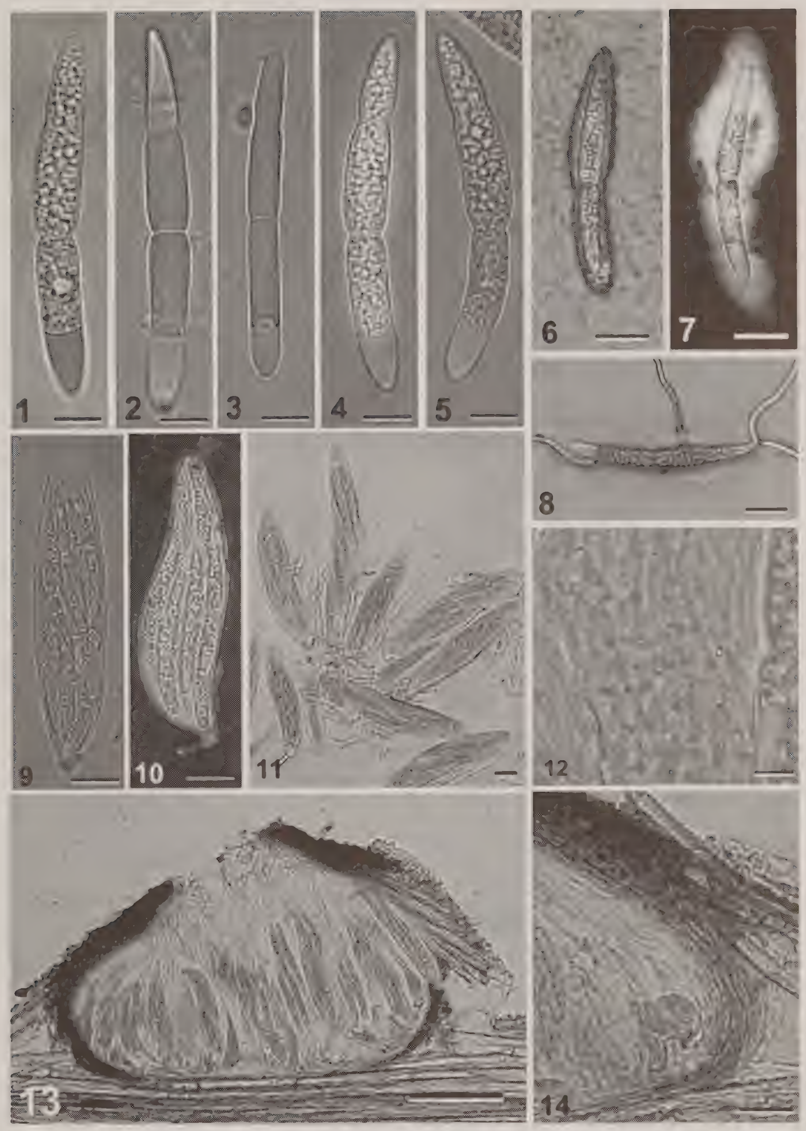
Etymology: from the Latin *magni-* meaning large, and the epithet of a similar species, *arundinacea.*

Ascomata 150–280 μm high, 310–410 μm diameter, scattered, erumpent, subglobose, flattened at the base, with sparse brown hyphae at sides. Beak central, short, slightly papillate, composed of dark brown globose cells of 2–4 μm diameter. Ascomal wall at sides 12.5–20 μm thick and composed of 4–5 layers of polygonal cells of 3–18 × 2–4.5 μm, at the base 5–7.5 μm thick and poorly developed. Pseudoparaphyses numerous, cellular, 1.5–3.5 μm thick, branched, with septa at 5- to 17- μm intervals. Asci (119–) 125–182.5 (–200) × 25–35 (–47.5) μm (mean = 151.5 × 30.2 μm, *n* = 37), fissitunicate, narrowly ovoid, rounded at the apex, short-stalked, with 8 tri- to tetraseriate ascospores. Ascospores 67–82 × 6.5–9 μm (mean = 74.0 × 7.7, *n* = 50), L/W 8.4–11.0 (mean = 9.6, *n* = 50), cylindrical to narrowly fusiform, mostly curved, with 1–2 septa, strongly constricted at the primary submedian septum (0.52–0.57; mean = 0.54, *n* = 50), weakly constricted at the middle of upper hemisphere, with an additional septum in the lower hemisphere, hyaline to pale olivaceous, smooth, with numerous small guttules in fresh condition, surrounded by a sheath. Sheath narrow at first, 3 μm thick at sides, 7 μm thick at the base, later enlarged in water, 11 μm at sides, 15 μm at the base.

CULTURAL CHARACTERISTICS — Colonies on potato dextrose agar (PDA; Difco, Detroit, MI, USA) 33 mm in diameter after incubation for 4 weeks at 20 °C in the dark, at first white, later Olive-Brown (4D3; Kornerup and Wanscher 1978) to Bluish-Grey (22D2), with irregular margin; reverse Dark-Green (28F3); no pigment produced. On rice straw agar (Tanaka and Harada 2003a), ascomata formed on the surface of rice straws within 2 months. Ascospores similar to those found in nature, (64.5–) 69–82.5 (–85) × (7–) 8–10 μm (mean = 75.3 × 9.3 μm, *n* = 65), L/W 7.2–9.7 (mean = 8.2, *n* = 65), and with a submedian primary septum (0.53–0.59; mean = 0.56, *n* = 65).

MATERIALS EXAMINED — **JAPAN:** Ariake small river, Ariake, Akkeshi, Hokkaido (144°52.0'E, 43°01.2'N), on submerged dead stems of an unknown herbaceous plant, June 3, 2003, K. Tanaka and S. Hatakeyama 1174 (maintained at Herbarium of Hirosaki University, Fungi: HHUF 28293 holotype; single ascospore culture MAFF 239294). Dried culture specimens grown on culms of *Oryza sativa* L., from culture MAFF 239294 (HHUF 28294, HHUF 28335, IMI 391849). Slides made from holotype (HHUF 28295, IMI 391850), Slide made from culture MAFF 239294 (HHUF 28296).

COMMENTS — *Massarina magniarundinacea* has cylindrical ascospores which are constricted at the primary septum and middle portion of upper hemisphere, and are surrounded by a mucilaginous sheath elongated below. These ascospore features are somewhat similar to those of *M. arundinacea* [= *Lophiostoma arundinacea* (Sowerby: Fr.) Aptroot & K.D. Hyde; Hyde et al., 2002]. However, the



Figs. 1–14. Micrographs of *Massarina magniarundinacea*. **1–5.** Ascospores; **6. 7.** Ascospores with a sheath (in India ink); **8.** Germinating ascospore; **9–11.** Asci; **12.** Cellular pseudoparaphyses; **13.** Ascomata in longitudinal section; **14.** Ascomal wall in longitudinal section. (1–3, 7, 8, 11, 13, 14 from holotype; 4–6, 9, 10, 12 from culture MAFF 239294). Scale bars: 1–5, 12 = 10 μm; 6–11, 14 = 20 μm; 13 = 100 μm.

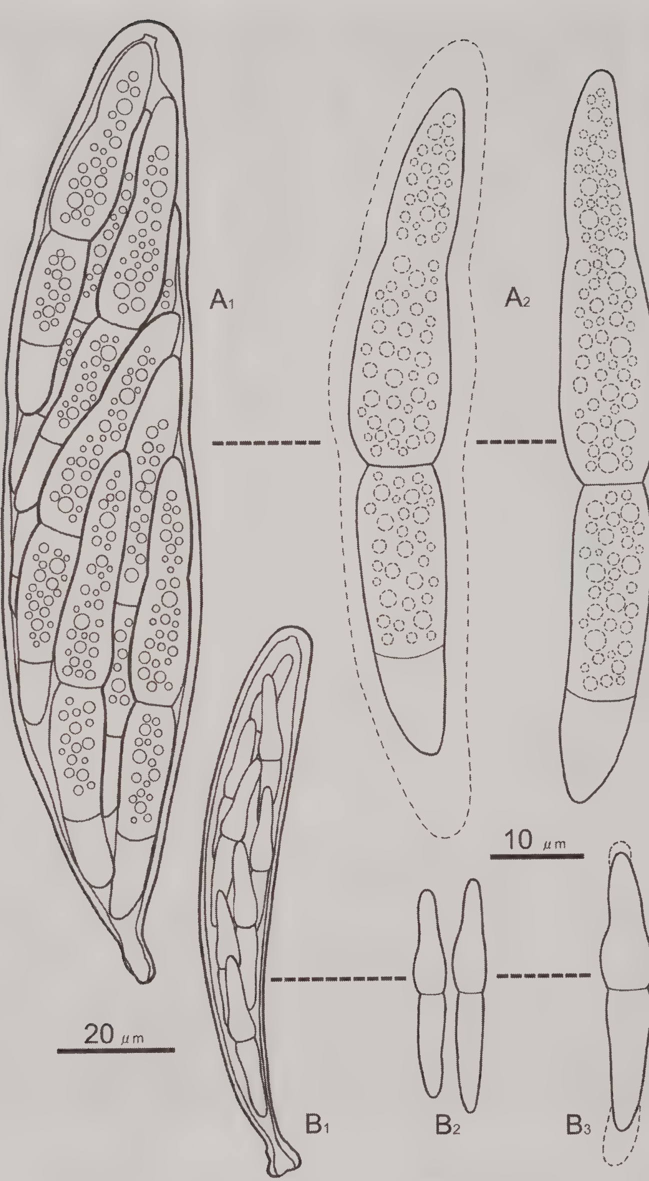

A_1
A_2
10 μm
20 μm
B_1
B_2
B_3

Fig. 15. Line drawings of *Massarina magniarundinacea* (**A**) and *M. arundinacea* (**B**). A_1. Ascus; A_2. Ascospores; B_1. Ascus; B_2, B_3 Ascospores. (A_1, A_2 from MAFF 239294; B_1, B_2 from HHUF 27542; B_3 from YAM 22555).

ascospore dimensions of *M. magniarundinacea* are considerably larger (67–82 × 6.5–9 *μ*m vs. 23–40 × 3.5–6 *μ*m in *M. arundinacea*, Tanaka and Harada 2003b). There are also important differences in the septal position of ascospores. The primary septum is clearly submedian (0.54) in *M. magniarundinacea*, but median (0.50) in the latter. The additional septum is always formed at lower hemisphere in *M. magniarundinacea*, but at upper hemisphere in the latter (Shoemaker and Babcock 1989). The morphological differences of ascus and ascospore between both species are illustrated in figure 15.

In addition, the colony characteristics on artifical medium differ in both species. The colony growth rates of *M. magniarundinacea* are very slow (33 mm on PDA / 4 weeks, at 20 °C in the dark) as compared to those of *M. arundinacea* (75 mm, same condition; Tanaka and Harada 2003b).

This species was found on a submerged herbaceous stem which was mainly colonized by *M. arundinacea*. The latter species, a common fungus on culms of *Phragmites australis* (Cav.) Trin. ex Steud., is known as a freshwater ascomycete (Shearer 1993). *Massarina magniarundinacea* also may have a freshwater habitat, but additional collections are needed to confirm this.

Acknowledgments

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Taxonomic notes on *Pannaria pallida* from southern South America and New Zealand

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Abstract – The genus *Psoroma sensu lat.* in southern South America is poorly known. Although there have been some new species reported, bibliographic revisions and species checklists published, no systematic revision has been undertaken. We now report our initial results of morphological, anatomical and chemical studies on two such species (*Ps. pallidum*, *Ps. pulchrum*). We have shown these two species to be synonymous. Furthermore, following the circumscription of *Pannaria* proposed by P.M. Jørgensen, we adopt here the name *Pannaria pallida*, previously proposed by Hue, as the valid combination.

Key words – lichens, *Pannariaceae*, Southern Hemisphere, emended description

Introduction

The genus *Psoroma* Michaux (1803) includes a heterogeneous group of lichens from the family *Pannariaceae* (lichenized Ascomycota). Despite of the fact that the first species of *Psoroma* were described from the Northern Hemisphere (including *Ps. hypnorum* (Valh.) Gray, the type species of the genus), it is now considered to be predominantly a Southern Hemisphere genus, with circumantarctic distribution (Galloway 1985, Jørgensen & Galloway 1992). Indeed, *Psoroma* is a widespread element in the subantarctic rainforests as well as in the Antarctic regions, where it grows on soil and over mosses (Henssen & Renner 1981, Galloway 1985). Until recently the genus included approximately 50 species, mainly from South America, New Zealand and Australia. More recently, the circumscription of the genus has undergone considerable changes (Jørgensen 1994, 2000, 2001, Elvebakk & Galloway 2003), which resulted in a number of foliose species being transferred to the genus *Pannaria* (type: *Pannaria rubiginosa* (Ach.) Bory). Characteristic features including the ascus tip, the related secondary chemistry as well as the morphology and the anatomy of the thallus suggested a close relationship between the foliose species of *Psoroma* and those of *Pannaria s. st.,* although they contain different types of photobionts (e.g. green algae including *Myrmecia* and cyanobacteria such as *Nostoc* respectively) (Jørgensen 1994, 2001).

However, no world monograph or comprehensive revision of *Psoroma* is available. Treatments of the genus in the Flora of New Zealand (Galloway 1985) and the Flora of Australia (Jørgensen & Galloway 1992) represent the most significant contributions to the knowledge of the genus; a revision of *Psoroma* in South America would be highly significant. Several new species have been described from South America over the past 50 years (Lamb 1953, 1955, James & Henssen 1975, Henssen & Renner 1981, Henssen et al. 1983, Henssen 1983, Scutari & Calvelo 1995, Jørgensen & Wedin 1999). Although bibliographic revisions and checklists for different South American countries have been published (Lamb 1958, Calvelo 1992, Galloway & Quilhot 1998, Calvelo & Liberatore 2001), no comparative study involving extensive fieldwork has been undertaken.

Psoroma pallidum was described by Nylander (1859), based on a South American collection (holotype: country not specified (probably Chile), Strait of Magallanes, D. Le Guillou and Lechler *supra linga putrescentia corticesque,* in Mus. Paris, ex herb. W. Nylander, nr. 30827, H). Unfortunately the type is very small and provides little information.

Malme (1925) described *Psoroma pulchrum* based on a collection from Tierra del Fuego (holotype: Fuegia (Argentina), Ushuaia, *habitat in truncis Fagi antarcticae* (*Nothofagus antarctica*), Dusén 257, L 5121, S). Although Malme studied specimens of *Ps. pallidum* collected by Dusén in Chile, he explicitly stated that he considered *Ps. pulchrum* and *Ps. pallidum* two separate species. They were segregated mainly by the structure of the upper cortex (stratified or non-stratified) and by additional anatomical features. Subsequently, Lamb (1953) reported on the poorly known species, *Ps. calophyllum* Müll. Arg., as well as notes regarding *Ps. pulchrum* and *Ps. pallidum.*

The present paper is the first contribution towards a revision of the genus *Psoroma* in South America, with special reference to the species occurring in Argentina. We have studied the morphology, anatomy and chemistry of *Ps. pulchrum* and *Ps. pallidum* and considered them to be synonymous. Furthermore we accept that *Ps. pallidum* belongs to *Pannaria,* as previously proposed by Hue (1902).

Material and Methods

Lichen collections – Collections from various herbaria were studied (BA, BACF, BCRU, BM, H, LIL, MSC, S), including specimens from South America, New Zealand and Australia. Recent collections from northwestern Patagonia, Nahuel Huapi National Park and surrounding areas were also investigated; the latter are preserved in private herbaria (Calvelo and Passo). Abbreviations for herbaria follow Index Herbariorum (Holmgrem & Holmgrem 2001).

Morphological and anatomical studies – Morphological observations were made under a dissecting microscope. Anatomical features of the thallus and the apothecia were examined by sections, using a compound light microscope. All anatomical sections and size measurements were determined on water-mounted slides. For descriptions of anatomical structures of the thallus and the fruiting bodies, sections were stained with lactophenol cotton blue. For a detailed study of the asci, the preparations were pretreated with a KOH solution (10%) and then with Meltzer´s reagent, in order to reveal the ascus tip structure.

Chemistry – Natural compounds were characterized by high performance liquid chromatography (HPLC) with retention index values (RI) calculated from benzoic acid and solorinic acid controls (Elix 1996; Elix & Wardlaw 2000; Feige et al. 1993). A Merck Hitachi Spectra System and a Beckman 5μ C18 column, and spectrometric detectors were used. Two solvent systems A and B were used: 1% aqueous orthophosphoric acid and methanol in the ratio 7:3 (A) and methanol (B). The HPLC was coupled to photodiode array detectors for ultraviolet spectroscopic comparisons. By this means the ultraviolet spectra observed for the various components eluting in the HPLC chromatogram were recorded and computer-matched against a library of ultraviolet spectra recorded for authentic metabolites under identical conditions. For a complete chemical profile TLC analyses were performed following standardized protocols (White & James 1985, Huneck & Yoshimura 1996).

Results

Table 1 provides a comparative summary of the main characters reported by Malme (1925) for *Ps. pulchrum* and *Ps. pallidum.*

Based on our examination of the type specimens of both species as well as several more recent collections, we reviewed the characters discussed by Malme (1925) and subsequently by Lamb (1953), regarding these two species.

Morphology – Figures 1a and 1b illustrate the type specimens of *Ps. pallidum* and *Ps. pulchrum.*

As mentioned previously the type specimen of *Ps. pallidum* is quite small. It is clearly foliose, but it is not possible to infer the lobe shape from it. No prothallus is visible. The upper surface is uneven, matt, and yellowish, while the lower surface is white at the margins but brownish in the centre. The rhizines are simple to squarrose, pale to buff. The apothecia are round, 2–3 mm in diameter, plane to slightly concave or irregular due to mutual pressure and pruinose when young. The cephalodia located on the lower surface are globose, 0.5–2 mm and concolorous with the thallus.

Psoroma pulchrum has a foliose thallus, ca. 10 cm in diameter. The lobes are laciniate, 2 to 4 mm wide and discrete at the margins, imbricate and overlapping in the centre. The upper surface is uneven, small papillose, matt, yellowish to yellow-brown. The lower surface is pale-buff at the margins but brown in the centre of the lobes. It is rhizinate, with white to brownish rhizines.

Table 1—Morphological and anatomical characters of *Psoroma pulchum* and *Psoroma pallidum,* extracted from Malme (1925).

Character	***Ps. pulchrum***	***Ps. pallidum***
Lobules	Laciniate, sublinear, 2-3 mm wide, margins notched	Laciniate
Color	Glaucous, creamy to yellow-brown	Creamy to yellow-brown
Upper surface	Uneven, verrucose, matt	--
Apothecia	Rounded, or deformed by mutual pressure. Disc plane 2-3 mm, pruinose.	Rounded, 2-2.5 mm
Thecium	200-250 μm	140-160 μm
I-Reaction	+ vinose rubescens	Positive
Paraphyses	Branched at apices	Simple
Spores	Globose to subglobose, 12-15 μm, epispore verrucose.	Ovoid, 12-17 to 9-12 μm. epispore ±smooth
Cortical structure	80 μm, stratified. Irregular, fused thick walled hyphae, and vertical pachydermatic cells.	70 μm manifestly parenchymatose

Apothecia are numerous, rounded to irregular due to mutual pressure. Disc 2–3 mm in diameter, orange to dark brown, plane to irregular, with an occasional central depression, pruinose when young. Cephalodia located on the lower face, globose to cerebroid.

The comparison of numerous collections of *Ps. pallidum* from Chile, Argentina and New Zealand, led us to detect some intraspecific variability regarding the thallus morphology. While some specimens exhibit a discrete and laciniate thallus, with sublinear and dichotomously branched lobes (Fig. 1c), other collections exhibit a disordered, imbricate growth form which is not clearly laciniate (Fig. 1d). The examination of numerous specimens *in situ* indicated that these characteristics are probably determined by ecological factors. From our field observations, *Ps. pallidum* specimens growing in the coldest subantarctic habitats, where they spread over mosses or on bark mixed with mosses or other lichens, often have irregularly arranged lobes (Fig. 1d). In such specimens the lobes are shorter and discrete only at the margin. The apothecia are crowded and usually have a central depression on the disc. In contrast, specimens from humid *Nothofagus* forests usually grow directly on bark and are not associated with other lichens. Such specimens have a discrete and clearly laciniate thallus, with less apothecia and plane discs (fig. 1c). Older, larger specimens tend to became more or less imbricate. The upper surface is less uneven, especially in collections from shaded habitats.

Both species have similar, globose cephalodia located in the lower surface.

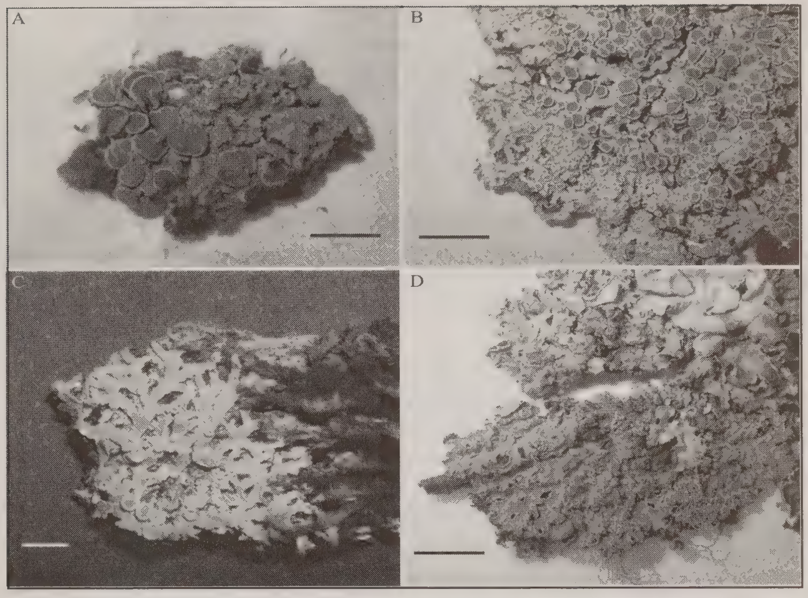
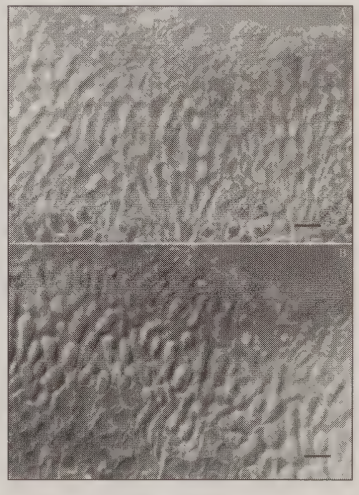


Figure 1 (above) – General view of mature thalli of : **A**. holotype of *Psoroma pallidum*; **B**, holotype of *Psoroma pulchrum*; **C** *Psoroma pallidum* Calvelo 831, from north western Patagonia; **D**, *Psoroma pallidum* L 47185 (S), from Magallanes, southern Chile. Bars: A= 0,5 cm; B= 1,5 cm; C= 0,5 cm; D= 1 cm.

Figure 2 (below right) – Thallus sections of the type specimens of *Ps. pallidum* (A) and *Ps. pulchrum* (B), showing the stratified structure of the cortex. Bar = 10 μm



Anatomical characters – Figure 2 shows the stratified structure of the cortical layer of *Ps. pulchrum* and *Ps. pallidum*. For both species, the external layer is formed from pale yellow hyphae, with thick, highly gelatinized walls, that are packed together and intertwined in various directions. This layer was defined by Lamb (1953) as "decomposed". The lactophenol stain causes the pale yellow coloration to became more evident, ultimately turning pale violet so that crystal incrustations can be clearly distinguished.

Immediately below this layer, a pseudoparenchymatous layer is present, formed from ±isodiametric, periclinal arranged cells. The type collection of *Ps.*

pallidum is so small that very few sections could be prepared. For this reason it was impossible to study the variability of the anatomical features within the thallus. However, variations in cortical height were studied in the type collection of *Ps. pulchrum*. In certain sections, the decomposed layer was significantly greater than in other sections and so was more conspicuous than that observed on the type material of *Ps. pallidum*. Consequently, this character proved to be ambiguous, with many intermediate forms observed for both “species”.

The algal layer is compact, with algae partially immersed within the cortex and 60–80 μm high; no differences were observed between the two species. The medulla is thick (100–150 μm), compact, with hyphae disposed subparallel to the cortex and with brown crystals deposited on the cell walls beneath the algal layer. No lower cortex was observed.

The height of the hymenium is quite variable in different specimens, and could not be studied in the apothecia of the type of *Ps. pallidum*. The iodine reactions of the hymenia did not revealed any differences between the two species. Both specimens exhibit a positive blue-reddish (blue, after washing with water) reaction. The ascus tips have no special apical structures, and only the surrounding of the ascus became stained. The ascospores of both “species” were identical, being globose to subglobose, 11–17 μm, with a thick, verrucose epispore.

Chemistry – Specimens of both species from different localities in South America and New Zealand were analysed. All showed the same chemical profile. The major medullary substance is the depsidone pannarin (Fig. 3a), with minor amounts of norpannarin (Fig. 3b), pannarin methyl acetal and two unknown pigments.

Some collections of *Ps. contortum* Müll. Arg. and *Ps. xanthomelanum* Nyl. form New Zealand and Australia, were also analysed for comparison purpose. *Ps. contortum* contained pannarin and contortin as the major substances, but also contains porphyrilic acid, while *Ps. xanthomelanum* contains contortin and zeorin as the major substances with small amounts of pannarin and its derivates.

Discussion

Lamb (1953) initially described the typical “decomposed” cortical layer for *Ps. calophyllum*, but also stated that it was similar to the cortical structure found in the type of *Ps. pulchrum*. However, we have now observed this structure in the type of both *Ps. pulchrum* and *Ps. pallidum,* even though it is slightly more obvious in the former. Our investigations indicated that this character is subject to variability induced by ecological factors, and many intermediate forms were observed. It is not possible to segregate the two species using such an ambiguous character.

Furthermore, it was apparent that the stratified cortex and especially the decomposed layer are responsible for the uneven appearance of the upper surface for both species. As previously mentioned, this character was also found to be ambiguous and variable. A similar relationship between the structure of the cortex and the appearance of the upper surface was also observed in other foliose species of *Psoroma*.

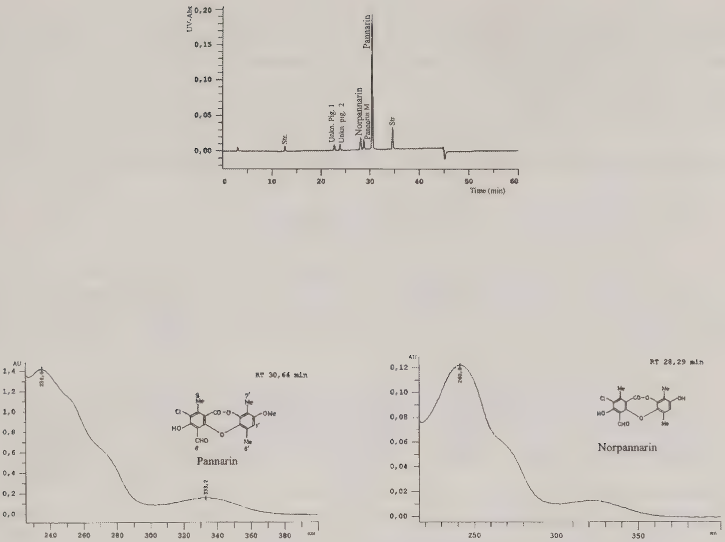


Figure 3 – Typical HPLC chromatogram, UV spectra and chemical structures of the depsidones, pannarin and norpannarin, extracted from the thallus of *Ps. pallidum* (str= standard substances).

Indeed, both *Pannaria sphinctrina* (Mont.) Hue and *P. rubiginosa* (Ach.) Bory have a smooth and shiny upper surface, and a cortex with an even epicortical layer formed from dead, gelatinized cells. By contrast, the New Zealand endemic *Ps. arenosum* Nyl., has a loosely arranged layer of hyphae, giving rise to the tomentose upper surface typical for this species (Passo, unpublished data).

Malme (1925) also used the shape of the ascospores and the anatomy of the apothecia to segregate the two species. However, as described above, we did not observe differences in:

- the height of the hymenia, as mentioned previously by Lamb (1953)
- the iodine reaction of the hymenia
- the ascus tips, since no apical structure was observed (only the surrounding of the ascus was stained).
- the ascospores, which are globose to subglobose, 11–17 μm, with a thick, verrucose epispore in both cases.

Indeed, Lamb (1953, 1958) recognized that the anatomical characters used by Malme (1925) were not sufficiently significant to segregate the two species, and that it would probably be better to separate *Ps. pulchrum* by the narrowly laciniate lobes, the absence of cephalodia, the globose ascospores with the typical verrucose epispore and the positive iodine reaction of the hymenia.

However, in our opinion these characters are also deficient, since the shape and size of the lobes depend on ecological factors. Similar ecological dependence was observed by James (1975) for the related species with laciniate lobes, *Pannaria durietzii* (P.W. James) Elvebakk & Galloway.

The absence of cephalodia is not a characteristic of *Ps. pulchrum* as the type specimen has well developed, globose to cerebrioid cephalodia on the lower surface.

Conclusion

As a result of the present investigation, we consider that the relevant morphological, anatomical and chemical characters, do not provide sufficient criteria to segregate *Ps. pulchrum* and *Ps. pallidum*. Consequently, we believe that *Ps. pulchrum* and *Ps. pallidum* are synonymous.

Furthermore, the various characters studied confirm that this species belongs to the genus *Pannaria* (Jørgensen 2001) as proposed by Hue (1902). An emended description of the species, outlining its intraspecific variability is given.

Pannaria pallida (Nyl.) Hue, *Bull. Soc. Bot. France*, 48: 56 (1902)
ammed. Passo, Calvelo & Stocker
≡ *Psoroma pallidum* Nyl., *Annal Scienc. Nat. Bot.* Ser. 4., 12: 294 (1859)

Holotype: Chile?, Magallanic Strait, D. Le Guillou-Lechler "*supra linga putrescentia corticesque*" (H-NYL 30827!)

Syn. Nov. Psoroma pulchrum Malme in *Ark. Bot. 20A* (3): 12 (1925)

Holotype: Fuegia (Argentina), Ushuaia, "*in truncis Fagi antarcticae*", 8-I-1896, Dúsen 257 ex herb. Gust. O. Malme, L 5121 (S!).

Thallus foliose, lobate, closely attached centrally, free at margins, without a prothallus, 6–10 cm wide. Lobes laciniate, radiating, discrete to ±imbricate, especially in the centre of large specimens; subdichomously to irregularly branched, 2–5 mm wide, 6–25 mm long. Lobe tips usually crisped and inrolled. Margins irregular, notched, thickened, sometimes with small secondary lobes in older parts. *Upper surface* distinctly to irregular-roughened, uneven, papillate, pruinose or minutely white-tomentose in younger parts, bright green when wet, pale greenish-grey when dry, yellowish-green-glaucous to yellow-brown in herbarium. *Lower surface* white at margins, cottony, tomentose, pale brown to buff centrally, distinctly rhizinate, especially in the centre. Rhizines short, to 2 mm, simple to squarrose, white at the margins, brown to buff, sometimes partially blue-black centrally, with cyanobacteria captured between the rhizines. *Cephalodia* present on lower surface, or rarely projecting from the margins or among rhizines and tomentum, simple, globose to cerebriform when large, buff or brown. *Apothecia* numerous, clustered, central, rarely marginal, disc red-brown, 0.5–4 mm, wide, densely bluish-white pruinose at first, smooth, rounded and plane to ±gyrose by mutual pressure, in some cases with central depressions, glabrous at maturity, margins concolorous with thallus, crenulate-sulcate, ±obscuring the disc at first.

Anatomy. Upper cortex 50–95 μm thick, stratified. Upper layer of thick walled hyphae, 3–5 μm thick, irregularly arranged, ±free to fused together by gelatinous material, 20 to 25 μm high. Lower layer pseudoparenchymatous, 50 to 70 μm high, with rounded isodiametric cells, periclinally arranged. Algal layer compact, sometimes with algae immersed in the cortex, 60–80 μm high. Medulla thick, 100–150 μm wide, compact, formed by hyphae, ±parallel to the upper surface, with brown crystals in the upper part. Lower cortex absent.

Apothecia: hymenium 140–200 μm high, paraphyses simple to branched at the tips, septate. Ascus clavate, ascospores 8, uniseriate, globose to subglobose, 11–18 μm, epispore thick, 2 μm, verrucose. Hymenium I+, surroundings of the ascus stain blue.

Chemistry: Medulla P+ orange. Pannarin (major), norpannarin (minor) and pannarin methyl acetal (minor/trace) and 2 unidentified pigments.

Selected specimens studied:

Psoroma pallidum: **ARGENTINA**, **Prov. de Río Negro**, Depto. Bariloche, Cerro Tronador, Ventisquero Negro, sobre tronco de *Nothofagus pumilio*, 11-XII-2001, Passo 04; Passo 05. Llao Llao, sobre tronco de *Nothofagos dombeyi*, XI-1992, Calvelo 831. Puerto Blest, I-1996, Calvelo 2069. Lago Guillelmo, 13-III-1989, Calvelo 2071. Arroyo Casa de Piedra, sobre *N. dombeyi*, 12-V-1991, Calvelo 2068.

Prov. de Tierra del Fuego, Isla de los Estados, Bahia Capitan Canepa, 3-XI-1971, H. Imshaug (52970), MSC 16213. Canal de Beagle, Lapataia, on the ground on a deforested hillside. 21-II-1940, Rolf Santesson, L 47183 (S). Isla Grande, *Nothofagus* forest near Hostería Alakush on Lago Roca, 25-XI-1971, Imshaug and Ohlsson, L 47184 (S). Lago Frio, on dying *Nothofagus*, on west of lake, alt. Ca. 100 ft., 24-I-1959, P.W. James (1246), BM 762051.

CHILE: **XII Región**, Península Brunswick, El Parrillar, sobre *Nothofagus*, 21-XII-1967, H. Imshaug (59300), MSC 93496. Isla Juan Fernández, Los Inocentes, 4-XII-1965, H. Imshaug (37470), MSC 80490. Magallanes, Rio Rubens, near Hotel Río Rubens (about 50 km SE of Natales), on *Nothofagus*, 12-I-1941, Rolf Santesson (5639), L 47188 (S). Tierra del Fuego, Canal Whiteside, Puerto Yartou, in fallen trunks in *Nothofagus betuloides-Drimys* forest, 29-I-1941, Rolf Santesson (5811), L 47186 (S), Rolf Santesson (6846), L 47185 (S). **X Región**, Peulla, Lago Margarita, sobre *N. dombeyi*, 10-II-1989, Calvelo 2105. Parque Nacional Vicente Perez Rosales, Petrohue, Río Petrohue near falls, alt. 500 m, on rocks and in *Nothofagus* forest, 10-X-1986, B.J. Coppins, D.J. Galloway, G. Guzman and P.W. James (4567), BM 762050, (4681), BM 762048, (4710) BM 762042. **IX Region**, Parque Nacional Conguillio, Parque de los Paraguas, Laguna Captren, alt. ca. 1000 m, *N. dombeyi* and *N. pumulio* forest, 20-XI-1986, B.J. Coppins, D.J. Galloway, G. Guzman and P.W. James (5319), BM 762049.

NEW ZEALAND: **South Island**, Canterbury, Puketariki Ecological Region, Craigeburn Range, Broken River, alt. 1040 m, on mountain beech, D.B. Rogan 125, 14-I-1998, MSC 672933 (ex AK 235435). Evoca Str. Lake Ohau, XI-1958, J. Murray, BM 762047. Craigieburn Forest Park, track from information centre to Lyndon Saddle, mountain beech forest (*Nothofagus solandri var. cliffortioides*), 8-IX-1981, F.J. Walker, BM 762045. Otago, Sugarloaf, IV-1958, Cess., BM 762041.

Psoroma contortum: **ARGENTINA**, **South-West Patagonia**, Cerro Mayo, on boles of *N. dombeyi,* near the Cerro Mayo glacier in small wood, contorted, pseodogyrose apothecia and pale lobes, 11-II-1959, P.W. James (2038), BM 762060.

CHILE: **Tierra del Fuego**, Canal Whiteside, Puerto Yartou, in *Maytenus magellanica*, 2-II-1940, Rolf Santesson (6751), BM 762059. Patagonia, Fjordo Andrew, on *Nothofagus betuloides* bark, 3-XII-1985, A. Newton, BM 762058.

AUSTRALIA: **North Queensland**, Atherton Tableland, Mount Lewis, above Julatten, in upland rain forest, 3000 ft, on trees, 18-4-1968, W.A. Weber BM 762043.

Psoroma xanthomelanum: **NEW ZEALAND, Auckland Islands,** Musgrave Harbour, on *Metrosideros*, 28-XII-1972, H. Imshaug (57063), MSC 144333. Smith Harbour, on *Metrosideros*, 01-I-1973, H. Imshaug (57240), MSC 144337. **Campbell Island**, Perseverance Harbour, on *Myrsine*, 16-I-1970, H. Imshaug (5434), MSC 104887, H. Imshaug (46066), MSC. 104882. Moubray Hill, 12-I-1970, H. Imshaug (46886), MSC 110666.

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The genus *Xanthoparmelia*, nom. cons. prop. (lichenized Ascomycota) in Slovakia

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Abstract—Seven species of *Xanthoparmelia* have been recorded for Slovakia, of which *X. angustiphylla* and *X. tinctina* are new for the country. The occurrence of *X. mougeotii*, previously reported as being extinct, was confirmed. The redetermination of all the specimens cited as *X. verrucigera* established that this species does not occur in the country. The species are segregated on the basis of morphological and chemical characters and notes on their taxonomy distribution and nomenclature are presented and a key to the species provided.

Key words—*Parmeliaceae*, chromatography

Introduction

Hale (1990) was the first to clearly delimit the genus *Xanthoparmelia*. He accepted 406 species worldwide but this has since increased to over 600 taxa (Giordani & al. 2002, Elix 2003). There are only 19 species of the genus reported for Europe in four chemotypes (viz. fumarprotocetraric acid, norstictic acid, salazinic acid and stictic acid) out of 40 known chemotypes (Giordani & al. 2002) and 7 species in Slovakia. Because *Chondropsis* Nyl. represents an older name for taxa sharing the same monophyletic clade as *Xanthoparmelia,* Hawksworth and Crespo (2002) have proposed the later name for conservation.

Xanthoparmelia has not previously been recognized as a distinct genus in Slovakia but was included in *Parmelia* sens. lat. in the last edition of the checklist (Pišút & al. 1998). There have been some previous studies on the taxonomy of the Slovak members of *Xanthoparmelia*. J. Suza studied the taxonomy of *X. mougeotii* (1934, 1950), *X. felkaensis* and *X. verrucigera* (Suza 1930, 1951; Paclová & Lisická 1998) but most papers reported floristic and biogeographical information on common species such as *X. conspersa* and *X. somloensis* (e. g. Suza 1945; Pišút & Lányi 1972; Pišút & Liška 1985). *X. protomatrae*, which is not a rare species, has been reported only once (Pišút 1983). Pustulková (1976) studied numerous voucher specimens (BRA, BRNM, BRNU, OP, PRC, PRM, SLO) for her thesis on the distribution of the genus *Parmelia* in

Slovakia but reported only three species, *X. conspersa, X. mougeotii* and *X. somloensis* (as *P. taractica*).

The checklist of lichens for the Western Carpathians (Bielczyk & al. 2004) gives incorrect information on the distribution of *X. sublaevis* and *X. tinctina*. In Europe the distribution of *X. sublaevis* is limited to the Iberian Peninsula and Italy (Hale, 1990; Giordani et al., 2002). Suza recorded this species as *P. molliuscula* var. *hypoclysta* and *P. conspersa* var. *hypoclysta* (Suza 1930, 1931a, 1931b, 1946; Suza et al. 1931). A number of these specimens have now been redetermined as *X. somloensis*. Thus the occurence of *X. sublaevis* in Slovakia, as well as in Czech Republic and Austria, is improbable despite various literature reports.

Materials and Methods

The present study is based on the critical examination of almost 700 *Xanthoparmelia* specimens from Slovakia (291 specimens) and other countries and of available type or original material held in institutional and private collections (BP, BRA, BRNM, G, GZU, LTM, NIM, PRC, PRM, ROM, SAV, TNP, W, ZAM, herb. County Museum Příbram, herb. A. Lackovičová, herb. E. Lisická, herb. P. Mráz, herb. V. Orthová, herb. I. Pišút, herb. A. Vězda).

The delimitation of taxa has been based on the morphological characters of the thalli, lobes, isidia, soredia, the colour of the lower surface, as well as on macrochemical tests on the medulla. These tests were supported by detection of specific compounds using thin layer chromatography, TLC (Culberson & Johnson, 1982 and White & James, 1985) and high performance liquid chromatography, HPLC (Feige & al., 1993). Synonymies have been validated by examining type specimens (where available).

The list of specimens studied records the exact citation of the collection site (numerical code in brackets refers to the UTM mapping scheme) for all type specimens as well as rare and interesting specimens from Slovakia. Herbarium/collection acronyms follow Index herbariorum (Holmgren & al., 1990). The detailed distribution of the species in Slovakia is presented on grid maps.

Taxonomy

Xanthoparmelia angustiphylla (Gyeln.) Hale, Mycotaxon 33: 401, 1988.
≡ *Parmelia conspersa* var. *angustiphylla* Gyeln., Feddes Repert. 29: 153, 1931.
= *Parmelia subconspersa* f. *marusica* Gyeln., Ann. Mycol. 36: 290, 1938.

Thallus ± pulvinate, loosely adnate to adnate to the substratum. *Lobes* 0.8-2 mm wide, subirregular to sublinear, dichotomously branched, contiguous to imbricate and sometimes densely laciniate with age. *Upper surface* dull yellowish green, emaculate. *Isidia* and *soredia* lacking. *Medulla* white. *Lower surface* black, moderately rhizinate. *Pycnidia* and *apothecia* common, *conidia* bifusiform.

CHEMISTRY Cortex K-; medulla K+ yellow to orange, C-, KC-, P+ yellow to orange. TLC: Usnic acid, stictic a., norstictic a. HPLC: Usnic acid (minor), stictic a. (major), constictic a. (minor), norstictic a. (minor) cryptostictic a. (minor), peristictic a. (trace), connorstictic a. (trace).

DISTRIBUTION AND HABITAT

The species has been reported from North America (Canada, USA) and Europe (Sweden, Belgium, Germany, Hungary, the former Czechoslovakia) (Hale, 1990) and Italy (Giordani & al. 2002). Despite this statement by Hale, no specimens identified as *X. angustiphylla* or *Parmelia subconspersa* f. *marusica* from Slovakia and/or Czech Republic were found among the herbarium collections. Neither Slovak (Pišút & al., 1998) nor Czech checklists (Vězda & Liška, 1999) list this species. Nevertheless, this species does occur in Slovakia on rock surface at elevation 250-1890 m but is an infrequently collected taxon. In Slovakia it has probably been overlooked and not segregated from the chemically similar *X. conspersa* and the morphologically similar *X. somloensis*.

NOTES

X. angustiphylla is similar in its morphology and chemistry (stictic acid chemosyndrome in the medulla) to *X. conspersa* but is nonisidiate. Skult (1992) noted that "*X. angustiphylla* cannot in my opinion be accorded recognition as a separate species. It seems to be an extreme morphotype within *X. conspersa*, an exponent of the great morphological variation of that species", but it is accorded species status in the present work.

Hale (1990) designated lectotypes for both *Parmelia conspersa* var. *angustiphylla* and *P. subconspersa* f. *marusica* even though they were based on single elements and thus represent holotype specimens (ICBN, Art. 9.1 and 9.8).

SPECIMENS EXAMINED

TYPES. Hungary. "Com. Nógrad Hungariae, pr. p. Diósjenő, in decl. m. Csóványos, ad rup. siliceum. in silva. alt. ca 600 m s. m., 1926.IV.24, leg. Dr. V. Gyelnik" (BP 21641T538, holotype of *Parmelia conspersa* var. *angustiphylla* Gyeln.). Romania. "Transsilvania. Marusicum. circa pagum Nagytalmács, ad terram, 1935.VII.13-14, leg. Dr. V. Gyelnik, det. 1936.VI. V. Gyelnik TYPUS" (BP 21624T719, holotype of *P. subconspersa* f. *marusica* Gyeln.).

SLOVAKIA. KREMNICKÉ VRCHY [7479a]: "Stará Kremnička [village], Potôčik, (zást. ČSAD), okraj lesa, vých. svah, na liparitovom kameni [rock], ca. 250 m, 28.11.1963, J. K. Lányi" (as *P. stenophylla*, BRA). MALÁ FATRA [6879a]: "Žilina, near village Strečno, right side river Váh, on the siliceous rocks behinde ruin Starý hrad (564.6 m) towards to Strečniansky priesmyk (slip), S-SW slopes, ca. 450-400 m, 19.8.2002, V. Orthová & A. Guttová" (SAV). MALÉ KARPATY [7669b, 7570c]: "hradisko Zámčisko [hill] pri Harmónii [part of town Modra], žula [granite], mach, 460 m, 23.V.1971, A. Follrichová" (as *P. stenophylla*, BRA), fr.!; "Častá village, valley Častianska dolina, debris (broken rocks) on south slope above game park, siliceous rock, ca 400 m, 29.10.2003, A. Guttová, A. Lackovičová & V. Orthová" (BRA). NÍZKE TATRY [7180d]: "Ad saxa schistosa cuprum continentia (strues fodinae lapidorum) supra pag. Špania dolina, ca. 750 m, 1.7.1993, E. Lisická" (BRA). POHRONSKÝ INOVEC [7577d]: "Nová Baňa [village]: Háj - káplnka "Ave Mária", les, západný svah, na liparitovom kameni [rock], ca. 280 m, 28.XI.1963, J. K. Lányi" (as *P. stenophylla*, BRA). STOLICKÉ VRCHY [7287d]: "Čierna Lehota [village], S od obce, dolina Lehotského potoka [valley] – ľavá strana, pod kótou 678,1, exp. JJZ, skalné bralo (vyvreté horniny) [rock], ca 615 m, 6.6.2001, D. Blanár" (BRA). TRÍBEČ [7575d]: "in monte Lysec supra pag. Velčice, ad saxa quartzitica 500 m, 5.1977, L. Opold" (as *P. somloensis*, BRA). VYSOKÉ TATRY [6886b]: "Batizovské pleso, 1890 m, granite, IX.1929, leg. J. Suza" (as *P. conspersa* var. *alpigena*, PRM 637070); "supra lacum Batizovské pleso, in rupibus graniticis mylonitisatis, alt. 1890 m s. m. – VIII.1964, A. Vězda" (herb. Vězda).

In total 11 Slovak specimens, 2 types and 4 other European specimens were studied (BP, BRA, PRM, SAV, herb. Vězda).

Xanthoparmelia conspersa (Ach.) Hale, Phytologia 28:485, 1974.

≡ *Lichen conspersus* Ach., Lich. Suec. Prodr.: 118, 1798; lectotype: Sweden, H; isolectotype BM.[1] [lectotype and isolectotype not seen].
= *Parmelia bakonyensis* Gyeln., Feddes Repert. 29: 154, 1931.
= *Parmelia atlantica* Gyeln., Feddes Repert. 29: 280, 1931, [non *P. atlantica* Ach.].
= *Parmelia conspersa* var. *vadaskertensis* Gyeln., Feddes Repert. 29: 291, 1931.
= *Parmelia bohemica* Gyeln., Feddes Repert. 30: 218, 1932.
= *Parmelia isidiata* f. *phonolitica* Gyeln., Feddes Repert. 30: 210, 1932.
= *Parmelia lojkana* f. *phonoliticola* Gyeln., Servít et Klement, Věstn. Král. České Společn. Nauk, Tř. Mat.-Přír. 2: 29, 1933.
= *Parmelia conspersa* f. *lignicola* Gyeln. et Fóriss, Gyeln. in Ann. Mycol. 36: 274, 1938.
= *Parmelia pseudoservitiana* f. *ornata* Gyeln., Ann. Mycol. 36: 287, 1938.
= *Parmelia isidiata* var. *adventiva* Gyeln., Feddes Repert. 29: 154, 1931.
= *Parmelia conspersa* var. *tatrensis* Suza, Acta Bot. Bohem. 9: 26, 1930.
= *Parmelia tarpatakensis* Gyeln., Magyar Bot. Lapok 29: 32, 1930.
= *Parmelia isidiigera* f. *ligustica* Gyeln., Ann. Mycol. 36: 281, 1938.

Thallus forming rosettes, adnate to loosely adnate to the substratum. *Lobes* 1-3 mm wide, subirregular, contiguous, margin brown rimmed, sometimes densely laciniate with age at the center. *Upper surface* yellowish-green, emaculate, isidiate. *Isidia* cylindrical, simply to coralloid branched with black tips. *Medulla* white. *Lower surface* black, with brown margins, sparsely rhizinate. *Pycnidia* rare, *conidia* bifusiform. *Apothecia* rather rare, the rim isidiate.

CHEMISTRY Cortex K-; medulla K+ yellow to orange, C-, KC-, P+ yellow to orange. TLC: Usnic acid, norstictic a., stictic a., cryptostictic a., constictic a. HPLC: Usnic acid (minor), stictic a. (major), constictic a. (minor), norstictic a. (minor) cryptostictic a. (minor), peristictic a. (trace), connorstictic a. (trace).

DISTRIBUTION AND HABITAT

The species has been reported from Europe, North and South America and Asia. It occurs from sea level to montane areas (Nimis, 1993) with an altitudinal range 150-1900 m in Slovakia. *X. conspersa* prefers silicate rocks, rarely growing on bark or wood. It appears that *X. conspersa* is retreating from high elevations of Vysoké Tatry Mts. in Slovakia where it was quite common in the past (Suza, 1926, 1927, 1932, 1949, 1951).

NOTES

The species has sometimes been confused with some closely related species. *X. angustiphylla* has similar chemistry (stictic acid) and a similar black lower surface but lacks isidia. *X. tinctina* is isidiate like *X conspersa*, but has globose isidia and contains salazinic acid in the medulla (K+ red). *X. verrucigera* is morphologically very similar to *X. conspersa* and must be distinguished by chromatography (stictic, lusitanic and verrucigeric acid but no norstictic acid), but it does not appear to occur in Slovakia.

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[1] according to Hale (1990).

Hale (1990) listed *Parmelia isidiigera* f. *ligustica* and *P. tarpatakensis* in synonymy with *X. verrucigera*. However, examination of the type specimens established that both represent *X. conspersa*.

The names *Parmelia bakonyensis*, *P. conspersa* var. *vadaskertensis*, *P. bohemica*, *P. isidiata* f. *phonolitica*, *P. lojkana* f. *phonoliticola*, *P. conspersa* f. *lignicola*, *P. isidiata* var. *adventiva* and *P. tarpatakensis* were based on single elements and thus represent holotype specimens (ICBN, Art. 9.1, 9.8) rather than lectotype specimens as designated by Hale (1990).

Indeed, Gyelnik himself noted that for *Parmelia conspersa* var. *vadaskertensis*, *P. isidiata* f. *phonolitica*, *P. conspersa* f. *lignicola*, *P. isidiata* var. *adventiva* and *P. tarpatakensis* "spec. orig. in herb. mus. Budapest".

SPECIMENS EXAMINED

Types. Hungary. "Com Veszprém prope pagum Csehát in monte "Szöllö hegy", ad rupem basalticum (!sic), ca 300 m s. m., 1925.VIII.18., leg. Gyelnik" (BP 22562T512, holotype of *Parmelia bakonyensis* Gyeln.). France. "Luxeuil (Hte Saone) sur un mur. 1.Aout 1906, legit Dr. Bouly de Lesdain" (BP 21226T511, lectotype of *P. atlantica* Gyeln. designated by Hale 1990). Hungary. "Budapesten. Vadaskert, ad rup. arenar., 1931.V.1., legit Gyelnik V." (BP 22654T549, holotype of *P. conspersa* var. *vadaskertensis* Gyeln., mixed with few thalli of *P. saxatilis*). Czech Republic. "Bohem. mer.: Příběnice, 360 m, 1926, Servít" (BP 21265T518, holotype of *P. bohemica* Gyeln.). Czech Republic. "N. W. Böhmen, Phonolith n. Rösselberg, ± 390 m, 1931, leg. Klement" (BP 22565T608, holotype of *P. isidiata* f. *phonolitica* Gyeln.). Czech Republic. "Nordböhmen: Mittelgebirge, Phonolithblockhalden am Selnitzberg, b. Brüx [Most], ± 400 m, 1931, leg. O. Klement" (BP 22581T620, holotype of *P. lojkana* f. *phonoliticola* Gyeln., mixed of few thalli of *P. saxatilis*). Slovakia. "Hungaria: com. Nógrad, Ad sepem lignum abietinum in pomariis Losoncz [Lučenec], ca 190 m, 11.sept 1909, Fóriss as *P. conspersa* f. *isidiata*, no. 105." (BP 21569T541, holotype of *P. conspersa* f. *lignicola* Gyeln. et Fóriss). France. "Gallia: Rochers granitiques Environs de Sangues, Haute Loire, Novembre 96, leg. Fr. Novatien" (BP 23380T658, lectotype of *P. pseudoservitiana* f. *ornata* Gyeln. designated by Hale 1990). Hungary. "Trachytsziklán a "Dobogókö" plateauján Dömös mel., Esztergom m., ca 700 m, 1920.VIII.7., gyüjt Timkó György no. 4369 (as *P. conspersa* f. *isidiata*)" (BP 22582T606, holotype of *P. isidiata* var. *adventiva* Gyeln.). Slovakia. "Tatra Magna: supra saxa granitica ad lacum Batizovské pleso, ca 1890 m, VII.1924, leg. J.Suza (as *P. conspersa* f. *tatrensis*)" (PRM 637082, lectotype of *P. conspersa* var. *tatrensis* Suza designated by Hale 1990). Slovakia. "Flora Hungarica Gránitsziklán a "Tarpatak" völgyében a 2-ik vizesés mellett a Magas-Tátrában, ca 1300 m, Szepes vm. Gyüjt. Timkó György no.3058, 1916.VII.9" [Mts. Vysoké Tatry, valley Malá Studená dolina near 2-waterfall – waterfalls stream Studeného potoka near Rainerova lodge] (BP 24152T735, holotype of *P. tarpatakensis* Gyeln.). Italy. "Flora ligustica B.co delle Foiche, rupe muscosa a Nord (Varazzo), I.II.1923, C. Sbarbaro no. 39." (BP 22563T609, lectotype of *P. isidiigera* f. *ligustica* Gyeln. designated by Hale 1990).

In total 182 Slovak specimens, 12 type, 24 other European specimens and 20 exsiccata were studied (BP, BRA, G, GZU, LTM, NIM, PRC, PRM, SAV, TNP, W, ZAM, herb.

Lackovičová, herb. Mráz, herb. Orthová, herb. Pišút, herb. Vězda).

Xanthoparmelia felkaensis (Gyeln.) Hale, Mycotaxon 33:403, 1988.
≡ *Parmelia conspersa* var. *felkaensis* Gyeln., Magyar Bot. Lapok 29: 32, 1930.
= *Parmelia conspersa* var. *alpigena* Suza, Acta Bot. Bohem. 9: 26, 1930.
≡ *Parmelia conspersa* f. *alpigena* (Suza) Hale, Smithsonian Contrib. Bot. 74: 115, 1990.

Thallus pulvinate, loosely adnate to the substratum. *Lobes* 0.6-1.2 mm wide, short and irregularly branched, appearing almost inflated, densely imbricate, margins crenate and black rimmed, short lobulate with age. *Upper surface* dark yellowish green, faintly white-maculate. *Isidia* and *soredia* lacking. *Medulla* white. *Lower surface* brown to black, sparsely rhizinate. *Apothecia* and *pycnidia* lacking.

CHEMISTRY Cortex K-; medulla K+ yellow turning red, C-, KC-, P+ yellow to orange. TLC: Usnic acid, norstictic a., salazinic a., protocetraric a. HPLC: Usnic acid (minor), salazinic a. (major), norstictic a. (trace), consalazinic a. (trace), protocetraric a. (trace).

DISTRIBUTION AND HABITAT

The species was reported by Hale (1990) from the former Czechoslovakia and Hungary. The "Hungarian" location is in fact situated in Slovakia [Magas Tatra, Felkai vizesés]. In the present study Slovak collections were all from the Vysoké Tatry Mts. According to the specimens studied (G, GZU) this species also occurs in Russia and Austria (first noted here!).

X. felkaensis is a saxicolous species preferring elevated sites with high humidity. It was collected around mountain lakes in the past but there are no recent collection from Slovakia.

NOTES

From its morphology and chemistry (salazinic acid), *X. felkaensis* would appear to be closely related to *X. somloensis*. It can be distinguished by its bright yellow-green pulvinate thallus with short inflated, black-margined imbricate lobes, the brown to black lower surface and by its occurrence at higher elevation. *X. somloensis* has broader, elongate lobes with a pale lower surface and occurs at sunny stands at lower elevation.

The name *P. conspersa* var. *felkaensis* was based on single element and thus this specimen represents a holotype (ICBN Art. 9.1, 9.8), rather than a lectotype as designated Hale (1990).

SPECIMENS EXAMINED

TYPES. Slovakia. "Granitsziklán a "Felkai vizesés" felett a patak medrében a Magas Tátra, ca 1820 m, Szepes vm. 1917.VIII.1., G. Timkó no. 3618." [Velická dolina valley, granitic rocks in stream bed under Velický vodopád waterfall] (BP 21618T539, holotype of *Parmelia conspersa* var. *felkaensis* Gyeln.; isotype BP 22661 here designated). Slovakia "Tatra Magna, ad saxa granitica ad lacum Batizovské pleso, ca 1890 m., VIII.1924, leg. J. Suza" (PRM 637068, lectotype of *P. conspersa* var. *alpigena* Suza designated by Hale 1990).

SLOVAKIA. VYSOKÉ TATRY [6886b; 6886a]: "Batizovské pleso 1890 m, ad saxa granitica, IX.1929, J.Suza" (as *P. conspersa* v. *alpigena*) (PRM 637071); "ad rupes granitica prope lacum Velické pleso, ca. 1680 m, VII.1921, J.Suza" (as *P. conspersa* f. *alpigena*) (PRM 637069); "ad saxa granitica mylonitisata inter montes Predná Bašta et Satan. ca. 2300 m, 5.10.1979, E. Lisická" (GZU; herb. Lisická).

Russia. "Caucasus centralis: distr. Tyrnyauz, regio montis Elbrus, in declivibus occidentalibus montis Cheget, 2400-2600 m, 26.6.1984. V. Vašák" (G 244494, as *P. taractica* Krempelh.); "ibid., in declivibus boreo-orientalibus montis Cheget, 2500-2800 m, 21.6.1980, V. Vašák" (G 218859, as *P. taractica*); "ibid., loco Staryj Krugozor dicto, 2900-3100 m, 22.6.1980, V. Vašák" (G 230626, as *P. taractica*). Austria. "Steiermark, Turrach, Eisenhnt, Gipfelfelsen 2440 m, 12.aug.1941, Dr. Karl Schittengruber" (GZU 67-92, as *P. conspersa* f. *hypoclysta*).

In total 7 Slovak specimens and 4 other European specimens (BP, G, GZU, PRM, herb. Lisická) were examined.

Xanthoparmelia mougeotii (Schaerer) Hale, Phytologia 28: 488, 1974.

≡ *Parmelia mougeotii* Schaerer, Enum. crit. lich. eur. p. 46, 1850; neotype: Switzerland, UPS; isoneotypes: BM, FH, WU.[2]

= *Parmelia mougeotii* f. *incurvoides* Servít, Věst. Král. České Společn. Nauk, Tř. Mat.-Přír. 2: 9, 1937.

= *Parmelia mougeotii* Schaer. f. *deminuta* Servít, Věst. Král. České Společn. Nauk, Tř. Mat.-Přír. 2: 9, 1937; lectotype: Czech Republic, PRM [designated by Hale, 1990 – not located in PRM!].

= *Parmelia mougeotii* f. *microphylla* Anders, Strauch- Laubflechten Mitteleur. p. 146, 1928.

Thallus foliose to subcrustose, tightly to very tightly adnate to rocks, rosette-like, usually areolate in the center, (0.5) 2-4 cm wide. *Lobes* sublinear, very narrow, 0.2-0.5 mm wide, subimbricate and crowded, ± flattened, apices rounded, margin brown rimmed. *Upper surface* dark yellowish-green to black, pale yellow-green at the margins, shiny, emaculate, rugose, transversely cracked with age, moderately sorediate. *Soralia* orbicular, capitate, 0.5-1 mm wide, *soredia* farinose. *Medulla* white. *Lower surface* black, sparsely to moderately rhizinate. *Pycnidia* rare, *conidia* bifusiform. *Apothecia* very rare, adnate.

CHEMISTRY Cortex K-; medulla K+ yellow to orange, C-, KC-, P+ orange. TLC: Usnic acid, norstictic a., stictic a., constictic a.

DISTRIBUTION AND HABITAT

X. mougeotii has a pantemperate distribution in cool humid regions of the world. The species has been reported from Europe, North, Central and South America, South Africa, Hawaii (Giordani & al., 2002), Asia Minor and Japan (Suza, 1950). The Slovak collection site (Malá Fatra Mts., near Strečno) is the easternmost enclave of the central/continental European distribution of the species (Orthová, 2003a). The sites situated further to the east, e.g. Poland (Cieśliński, 2003), Latvia, Estonia and Lithuania (Motiejūnaitė, 2002) are influenced by a more oceanic climate.

This species grows on exposed acidic rocks, including granites and sandstones, with relatively flat and smooth surfaces, seldom on bark (Hale, 1990). *X. mougeotii* is common in places with heather (*Calluna vulgaris*) and more rarely with birch (*Betula verrucosa*). In shaded positions it grows associated with heather (*Calluna vulgaris*) and blueberry (*Vaccinium myrtillus*) (Suza, 1934, 1950) at elevation 380-450 m.

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[2] according to Hale (1990).

In Slovakia *X. mougeotii* was reported as being extinct (Pišút, 1985; Pišút et al. 1996; Pišút et al. 1998; Pišút et al. 2001) but was recollected in 2002.

NOTES

X. mougeotii may be confused with the morphologically similar green-coloured sorediate species, *Arctoparmelia incurva* (Pers.) Hale and *Parmeliopsis ambigua* (Wulfen) Nyl. Soralia of *X. mougeotii* are situated in the central part of the thallus and are small, hemispherical and never protruding, while the soralia of *A. incurva* are protruding and situated at the end of the lobes. Apart from chromatography, the most effective way to distinguish these species is to use UV light, the medulla of *A. incurva* is luminiscent blue (alectoronic acid) while the medulla of *X. mougeotii* (stictic acid) and *P. ambigua* (divaricatic acid) are UV-.

Macrochemical reactions of the medulla and soralia may also assist in identification. In *P. ambigua* the medulla reacts K-, P- and UV+ vivid white whereas in *X. mougeotii* the medulla and soralia are K+ yellow to orange, KC-, P+ orange, UV- and *A. incurva* reacts is K-, KC+ pink and UV+ glaucous blue.

Probably the only available specimen associated with the name *Parmelia mougeotii* f. *microphylla* Anders is no. 333 of Anders' Lichenes exsiccati (Hale, 1990 noted specimen as "a possible topotype"). It is designated as a lectotype here.

SPECIMENS EXAMINED

TYPES. France. "Ad saxa silacea in summo m. Heledré prope Brujerium Mougeot, Schaerer, Lichenes Helvetici Exsiccati no. 548" (BRA B-302, isoneotype of *Parmelia mougeotii* Schaer. designated by Hale 1990). Czech Republic. "Železné hory: Mrákotínský kopec 500 m, 15.7.1930, leg. J. Nádvorník, det. Servít" (BRA, lectotype [B-303] and isolectotype [B-304] of *P. mougeotii* f. *incurvoides* Servít here designated). Czech Republic. "Železné hory: Mrákotínský kopec 500 m, 15.7.1930, leg. J. Nádvorník, det. Servít" (BRA B-131, syntype of *P. mougeotii* f. *deminuta* Servít designated here). Czech Republic. "Auf morschem Sandstein im Kiefernwald b. Aschendorf n. B. Leipa, ca. 270 m s. m. Lupe! Selten. 11.VIII.1933. leg. J. Anders. Anders, Lichenes exsiccati no. 333" (PRM 835448, lectotype of *P. mougeotii* f. *microphylla* Anders designated here).

SLOVAKIA. MALÁ FATRA [6879a]: "Žilina: ad ripam dextram flum. Váh prope pag. Strečno (apud ruinam arcis Starý hrad) in rupibus graniticis, ca. 380 m, J. Suza, Suza: Lich. sel. exs. no. 234. Fasc. VIII. (1933)" (BRA, PRC, PRM, BRNM); "ibid., near Strečno village, right side river Váh, on the siliceous rocks behinde ruin Starý hrad (564,6 m) towards to Strečniansky priesmyk (slip), S-SW slopes, ca. 450-400 m, 19.8.2002, V. Orthová & A. Guttová" (herb. Orthová).

CZECH REPUBLIC. "Bohemoslovakia – Bohemia orient., Hlinsko: in cacumine collis "Mrákotinský kopec" prope pagum Mrákotín, alt. 570 m s. m – 17.IV.1960. Ad saxa schistosa in Calluneto. A. Vězda, Vězda: Lich. sel. exs. no. 21." (BP 49971T953, "locus classicus" of *P. mougeotii* f. *incurvoides* Servít).

In total 5 Slovak specimens, 4 types, 34 other specimens and 25 exssicata were studied (BP, BRA, BRNM, PRC, PRM, W, herb. Orthová, herb. Pišút).

Xanthoparmelia protomatrae (Gyeln.) Hale, Phytologia 28:488, 1974.
≡ *Parmelia protomatrae* Gyeln., Feddes Repert. 29: 155, 1931.
= *Parmelia mitrovicensis* Gyeln., Feddes Repert. 30: 216, 1932.
= *Parmelia protomatrae* f. *angustifolia* Gyeln., Feddes Repert. 29: 155, 1931.
= *Parmelia protomatrae* f. *crustaeformis* Gyeln., Feddes Repert. 29: 155, 1931.
= *Parmelia protomatrae* var. *tenuior* Gyeln., Feddes Repert. 29: 155, 1931.
= *Parmelia serbica* Gyeln., Feddes Repert. 30: 216, 1932.
= *Parmelia conspersa* f. *matrae* Gyeln., Ann. Mycol. 30: 450, 1932.
= *Parmelia subconspersa* var. *varazzana* Gyeln., Feddes Repert. 36: 164, 1934.
= *Parmelia nigrescens* Gyeln., Ann. Mycol. 36: 284, 1938.

Thallus loosely adnate to the substratum. *Lobes* 1-2 mm wide, sublinear, elongate, dichotomously branched, separate to contiguous, laciniate at the center with age. *Upper surface* yellowish green, shiny, white maculate. *Isidia* and *soredia* lacking. *Medulla* white. *Lower surface* pale or dark brown, moderately rhizinate. *Pycnidia* common, *conidia* bifusiform. *Apothecia* common.

CHEMISTRY Cortex K-; medulla K± brownish, C-, KC-, P+ crimson red. TLC: Usnic acid, fumarprotocetraric a., protocetraric a., salazinic a. HPLC: Usnic acid (minor), fumarprotocetraric a. (major), quaesitic a. (minor), protocetraric a. (minor), succinprotocetraric a. (trace), salazinic a. (trace).

DISTRIBUTION AND HABITAT

The species has been reported from Norway, France, Belgium, Italy, Hungary, the former Yugoslavia and USSR, Saudi Arabia, China (Hale, 1990), Czech Republic (Vězda & Liška, 1999) and Slovakia (Pišút et al., 1998) from altitudes of 150 m to 1200 m. It occurs in similar sites and often together with *X. somloensis*.

The taxon is not very rare even though only one collection was reported prior to the 1980s (Pišút, 1983; Pišút & al., 1993). The voucher specimen for that report (Burda Mts., 1956 by I. Pišút) was not located in BRA but only a specimen from the same site, originally identified as *Parmelia stenophylla*. The present study established that *X. protomatrae* occurs in 17 geographical regions of Slovakia.

NOTES

Morphologically very similar to the common *X. somloensis*, *X. protomatrae* contains fumarprotocetraric acid (medulla K± brownish, P+ crimson red) whereas *X. somloensis* contains salazinic acid (medulla K+ red, P+ yellow to orange).

As the names *Parmelia protomatrae*, *Parmelia protomatrae* f. *angustifolia*, *P. protomatrae* f. *crustaeformis*, *P. protomatrae* var. *tenuior*, *P. conspersa* f. *matrae* and *P. nigrescens* were based on single elements they represent holotype specimens (ICBN Art. 9.1, 9.8) rather than lectotype specimens as designated by Hale (1990).

SPECIMENS EXAMINED

TYPES. Hungary. “Prope Budapest, m. Vadállókövek, 1926.VIII.18., leg. Gyelnik” (BP 21645T656, holotype of *Parmelia protomatrae* Gyeln.). Serbia. “in saxis ad Mitrovica, alt. 500 m. s. m., 18.X.1916, leg. Andrasowsky” (BP 23309T624/b, lectotype of *P. mitrovicensis* Gyeln. designated by Hale 1990). Hungary. “Hungaria, com. Heves, in montibus Mátra, in m. Hegyes hegy, ad rup. vulcanic., ca 600 m, 1925.VI.1., leg. Gyelnik” (BP 21652T655, holotype of *P. protomatrae* f. *angustifolia* Gyeln.). Hungary. “Com. Heves Hungariae, in montibus

Mátra, in cacum. m. Ajnácskő, ad rup. vulcanic., ca 600 m, 1925.VI.2., leg. Gyelnik" (BP 21662T654, holotype of *P. protomatrae* f. *crustaeformis* Gyeln.). Hungary. "Albae Carolinae, Pulverturm, 26. aug., Haynald" (BP 21625T714, holotype of *P. protomatrae* var. *tenuior* Gyeln.). Serbia. "Serbia in saxis trachitico-andesiticis ad montem Zvecan prope Mitrovica, ca 750 m, leg. 15.X.1916, Andrasowsky" (BP 23873T702/a, lectotype of *P. serbica* Gyeln. designated by Hale 1990). Hungary. "Com. Heves, in montibus Mátra, in cacumine montis Saskő, ad rupem andesiticam, ca 750 m, 1930.VII.23., leg. Gyelnik" (BP 21723T542, holotype of *P. conspersa* f. *matrae* Gyeln.). Italy. "Italia *Parmelia conspersa* forma No. 14b. Flora ligustica. Varazza: Mt. Bonomo, 1922.X.2., leg. Sbarbar" (BP 21633T722, lectotype of *P. subconspersa* var. *varazzana* Gyeln. designated by Hale 1990; original material in herb. Bouly de Lesdain destroyed). Hungary. "Hungaria. In montibus Bükk, Szarvaskő, Pyrkersziklák, ad rupem diabasicum, supra muscos, 1934.VII.23., leg. Gyelnik" (BP 22693T629, holotype of *P. nigrescens* Gyeln.).

In total 28 Slovak specimens, 9 types, 74 other European specimens and 16 exsiccata were studied (BP, BRA, BRNM, G, GZU, LTM, PRC, PRM, W, ZAM, herb. County Museum Příbram, herb. Mráz, herb. Orthová, herb. Pišút, herb. Vězda).

Xanthoparmelia somloensis (Gyeln.) Hale, Mycotaxon 28:96, 1987.

≡ *Parmelia somloënsis* Gyeln., Feddes Repert. 29: 156, 1931.
= *Parmelia conspersa* f. *viridulo-umbrina* Gyeln., Magyar Bot. Lapok 29: 31, 1930.
= *Parmelia convoluta* var. *subdensa* Gyeln., Feddes Repert. 29: 285, 1931.
= *Parmelia hypopallida* Gyeln., Feddes Repert. 30: 217, 1932.
= *Parmelia pseudohungarica* var. *komotauensis* Gyeln., Feddes Repert. 30: 217, 1932.
= *Parmelia imitans* var. *imbricatoides* Gyeln., Feddes Repert. 36: 156, 1934.
= *Parmelia laxa* var. *rosettaeformis* Gyeln., Feddes Repert. 36: 158, 1934.
= *Parmelia laxa* f. *borealis* Gyeln., Feddes Repert. 36: 159, 1934.
= *Parmelia subpolyphylloides* Gyeln., Feddes Repert. 36: 165, 1934.
= *Parmelia imitans* f. *arenicola* Gyeln., Ann. Mycol. 36: 278, 1938.

Thallus loosely adnate to the substratum or very rarely free growing. *Lobes* 1-10 mm wide, sublinear, elongate and dichotomously branched, imbricate, margin brown rimmed. *Upper surface* yellowish green, darkening with age, white maculate. *Isidia* and *soredia* lacking. *Medulla* white. *Lower surface* pale brown to dark brown, moderately rhizinate. *Pycnidia* common, *conidia* bifusiform. *Apothecia* common.

CHEMISTRY Cortex K-; medulla K+ yellow turning red, C-, KC-, P+ yellow to orange. TLC: Usnic acid, norstictic a., salazinic a., protocetraric a. HPLC: Usnic acid (minor), salazinic a. (major), norstictic a. (trace), consalazinic a. (trace), protocetraric a. (trace).

DISTRIBUTION AND HABITAT

This species occurs in Europe, central and eastern Asia and eastern North America (Giordani & al., 2002). In Slovakia this species is recorded in 28 geomorphological areas. The species is known to be saxicolous, to spread over gravel soils or rarely/ exceptionally on sand dunes (Borská nížina lowland in Slovakia). It usually occurs on sunshine-exposed siliceous rocks at elevation between 140-1950 m.

NOTES

The species is closely related to *X. felkaensis* (morphologically and chemically) and to *X. protomatrae* (morphologically).

The names *Parmelia conspersa* f. *viridulo-umbrina*, *P. convoluta* var. *subdensa*, *P. laxa* var. *rosettaeformis* and *P. imitans* f. *arenicola* were based on single elements they represent holotype specimens (ICBN, Art. 9.1, 9.8) rather than lectotype specimens as designated by Hale (1990).

In spite of the fact that '*Parmelia conspersa* f. *convoluta* Rabenh.' is a nomen nudum. Hale (1990) designated both lectotype and isolectotype specimens for this species.

SPECIMENS EXAMINED

Types. Hungary. "Com. Veszprém prope pagum Doba, in declivibus montis "Somló", ad rupem basalticam, ca 400 m, 1925.VIII.19, leg. Gyelnik" (BP 21738T704, lectotype of *Parmelia somloënsis* Gyeln. designated by Hale 1990). USA. "On rocks, Plitt, Baltimore, 3.IV.1916, Culb., (as *P. conspersa*)" (BP 33914T550, holotype of *P. conspersa* f. *viridulo-umbrina* Gyeln.). Russia. "In rupe ad Adil-Su (Lojka: It. Cauc. n. 404 as *P. conspersa* f. *polita*)" (BP 21754T552, holotype of *P. convoluta* var. *subdensa* Gyeln.). Czech Republic. "Bohem sept.: Komotau, 1930, Klement 14599, det. Gyelnik" (BP 22518T593, lectotype of *P. hypopallida* Gyeln. designated by Hale 1990). Czech Republic. "Bohem. sept.: Komotau, 1930, leg. Klement 14598, det. Gyelnik" (BP 23374T661, lectotype of *P. pseudohungarica* var. *komotauensis* Gyeln. designated by Hale 1990). Mexico. "Mexique: *Parmelia conspersa* var. *hypoclysta* Nyl., Mexico: formade larges plaques sur les Mochers, Rio Frio, 29.Janvier 1927, leg. Frére Amable." (BP 22524T596, lectotype of *P. imitans* var. *imbricatoides* Gyeln. designated by Hale 1990; original material in herb. Bouly de Lesdain destroyed). Hungary. "Gyérfüves, mohás homokbuczkán az Örkényi erdő tisztásán ca. 130 m. Örkény mal., Pest m. 1915.V.30. gyüjt Timkó György (as *P. conspersa*) Spec. orig no. 2165/2" (BP 21704T547, holotype of *P. laxa* var. *rosettaeformis* Gyeln.). Sweden. "E.P. Vrang. Lichenes insulae Torsö. *Parmelia molliuscula* Ach., Torsö: Klippingsberg, Juli 1930, 45-65 m (as *P. pulvinaris* f. *borealis*)" (BP 21643T613, lectotype of *P. laxa* f. *borealis* Gyeln. designated by Hale 1990). Japan. "Japonia *P. conspersa* Abbé Faurie lichens du Japon. No. 1373. Insula Riiskéri, leg. Faurie, Julio 1899" (BP 24010T724, lectotype of *P. subpolyphylloides* Gyeln. designated by Hale 1990; original material in herb. Bouly de Lesdain destroyed). France. "Gallia: Canet-Plage prope oppidum Perpignan, ad terram arenaceam, 1933.IX., legit Moesz G." (BP 22500T595, holotype of *P. imitans* f. *arenicola* Gyeln.). Germany. "Auf erratischen Blöcken zwischen Grimma und Hohenstädt in Sachsen, legit Ettich. Rabenhorst, Lichenes europaei no. 891." (BP 21741, '*P. conspersa* f. *convoluta* Rabenh.'; nom. nud.).

Hungary. "County Veszprém. On the silicaceous (basalt) rocks of the Mt. Somló, 2 km S of Somlószölös and Doba, 300-350 m a.s.l., leg. E.Farkas et L.Lökös, 9.V.1987" (BP 8701/A, as *Xanthoparmelia somloënsis*, herb. Vězda; BRA; "locus classicus" of *Parmelia somloënsis* Gyeln.).

In total 72 Slovak specimens, 12 type and 47 other European specimens and 34 exsiccata were studied (BP, BRA, BRNM, G, GZU, LTM, PRC, PRM, ROM, ZAM, W, herb. County Museum Příbram, herb. Lackovičová, herb. Mráz, herb. Orthová, herb. Pišút, herb. Vězda).

Xanthoparmelia tinctina (Maheu et Gillet) Hale, Phytologia, 28: 489, 1974.

≡ *Parmelia tinctina* Maheu et Gillet in Bull. Soc. Bot. N. France 72: 860, 1925, [holotype: not seen].

= *Parmelia Körösi-Csomae* Gyeln., Feddes Repert. 29: 156, 1931.

= *Parmelia tokajensis* Gyeln., Feddes Repert. 29: 154, 1931.

= *Parmelia rosea* Gyeln., Feddes Repert. 29: 285, 1931.

= *Parmelia rosea* f. *adventiva* Gyeln., Ann. Mycol. 36: 287, 1938.

Thallus rosette-forming, adnate to loosely adnate to the substratum. *Lobes* subirregular, contiguous to imbricate, 1.5-4 mm wide; apices rotund, margin not black rimmed. *Upper surface* yellowish grey, shiny near periphery, dull in the centre (coriaceous), emaculate, continuous, moderately to densely isidiate. *Isidia* globular to irregularly inflated, thick, the tips syncorticate, pale, rarely weakly erumpent, mostly simple, more rarely branched. *Medulla* white. *Lower surface* black, marginal area brown, sparsely rhizinate. *Pycnidia* rare, *conidia* bifusiform. *Apothecia* rare.

CHEMISTRY Cortex K-; medulla K+ yellow turning red, C-, KC-, P+ yellow to orange. TLC: Usnic acid, salazinic a. and norstictic a. HPLC: Usnic a. (minor), salazinic a. (major), consalazinic a. (trace), norstictic a. (trace), protocetraric a. (trace).

DISTRIBUTION AND HABITAT

This species has been reported from Sweden, France, Spain, Portugal, Italy, Hungary, Romania, Greece, Bulgaria, the former USSR and Yugoslavia, Algeria, Morocoo, Pakistan (Hale 1990), Madeira (Tavares, 1952; Alstrup, 1991), England (Purvis & al., 1992), Czech Republic (Vězda & Liška, 1999) and India (Divakar & Upreti, 2002). The present study extends this species distribution to Slovakia in Podunajská pahorkatina Mts., Tríbeč Mts. and Zemplínske vrchy Mts. This is a new record for the Slovak lichen flora.

The species is only known to be saxicolous and usually occurs on sunny siliceous rocks at elevation between 200-460 m.

NOTES

X. tinctina is characterized by globose, inflated, pale tipped isidia, a black lower surface and the salazinic acid complex in the medulla. It may be confused with *X. conspersa*, which has simple cylindrical or coralloid branched isidia and the stictic acid complex in the medulla.

Gyelnik (1932a: 215) was the first to report *X. tinctina* (as *P. isidiata* var. *isidiosa*) in Slovakia. His report is, however, erroneous as the voucher specimen is actually *X. conspersa* [Hungary. Comit. Ung, Ad lapidem trachyticum prope pagum Jósza [Jovsa], alt. ca. 180 m, 16.VI.1914, leg. Szatala (sub n. *P. conspersa* f. *isidiata*) (BP 44638), 7198c]. The occurence of *X. tinctina* in Slovakia was not confirmed until the specimens collected in 1961 (BRA) were studied by the author in 2002 and published for the first time here.

As the names *Parmelia tokajensis*, *P. rosea* and *P. Körösi-Csomae* were based on single elements they represent holotype specimens (ICBN Art. 9.1, 9.8) rather than lectotype specimens as designated by Hale (1990).

SPECIMENS EXAMINED

Types. Ukraine. "Jalta mit Cilarowski, Lojka It. Cauc. 87. (as *Parmelia conspersa*)" (BP 22611T611, holotype of *P. Körösi-Csomae* Gyeln.). Hungary. "Com. Zemplén, pr. opp. Tokaj, in cacum. M. "Tokaji hegy" ad rup. siliceam, alt. ca 500 m s. m., 1925.VII.27. leg. Dr. V. Gyelnik" (BP 22563T739, holotype of *P. tokajensis* Gyeln.). Ukraine. "In rupe arenaria prope Jalta in peninsula Taurica (Lojka: It. Cauc. N. 88 as *P. conspersa* f. *coralloidea*), Fertilis" (BP 23361T686, holotype of *P. rosea* Gyeln.). France. "Gallia. Parrique Parmelieés No. 39. (as *P. conspersa* v. *stenophylla* f. *isidiosa*) Parois verticales des roches granitiques, St. Bonnet le Château, Loire, avril 1905, G. Parrique" (BP 23562T689, lectotype of *P. rosea* f. *adventiva* Gyeln. designated by Hale 1990; original material in herb. Bouly de Lesdain destroyed).

Slovakia. Podunajská pahorkatina [7776b]: “Mochovce [village], kóta Dobrica, kremence [quartzite], ca. 320 m, 23.4.2003, A. Lackovičová” (herb. Lackovičová). Tríbeč [7674d]: “Zobor [hill] nad Nitrou [village], Malá skala – skaly [rock], 360 m, 18.aug.1961, L.Opold” (sub n. *P. stenophylla* mixed with. few thalli of *X. somloensis*) (BRA); “ibid., Kremičité skaly [siliceous rocks] pod nov. pyramídou, z juž. str., 460 m, 20.8.1961, L. Opold (as *P. conspersa*)” (BRA); “Nitra village – Zobor, SW slopes of the elevation Malá skalka by the abandoned quarry, quartzite cliffs, on rock, ca. 320 m, 18.4.2002, V. Orthová, A. Guttová & J. Košťál” (herb. Orthová). Zemplínske vrchy [7596c]: “Viničky [village]. Nad vinohradmi, 17.5.1977, E. Votavová” (BRA).

In total 13 Slovak specimens, 4 types, 30 other European specimens and 1 exsiccatum were studied (BP, BRA, PRM, herb. Lackovičová, herb. Orthová, herb. Vězda).

Xanthoparmelia verrucigera (Nyl.) Hale, Smith. Contr. Bot. 74: 220, 1990.

≡ *Parmelia verrucigera* Nyl., Flora, 56: 196, 1873; lectotype: France, H [designated by Hale, 1990] [not seen].

= *Parmelia pseudoservitiana* Gyeln., Feddes Repert. 36: 163, 1934.

= *Parmelia servitiana* Gyeln., Servít Hedwigia 71: 273, 1931.

= *Parmelia pulvinaris* (Zahlbr.) Gyel. var. *mediterranea* Gyeln., Servít Hedwigia 71: 272, 1931.

= *Parmelia pseudoservitiana* f. *exornata* Gyeln., Ann. Mycol. 36: 287, 1938.

Thallus adnate to the substrate. *Lobes* subirregular, contiguous to imbricate, 1-3 mm wide. *Upper surface* yellowish green, shiny, continuous, emaculate, (coriaceous), isidiate. *Isidia* verrucose to cylindrical, the tips syncorticate, darkening, sparsely branched. *Medulla* white. *Lower surface* black, moderately rhizinate. *Pycnidia* rare, *conidia* bifusiform. *Apothecia* not commonly developed, the rim isidiate.

CHEMISTRY Cortex K-; medulla K+ yellow, C-, KC-, P+ yellow to orange. TLC: Usnic acid, stictic a., constictic a. HPLC: Usnic acid (minor), stictic a. (major), constictic a. (submajor), verrucigeric a. (minor), cryptostictic a. (trace), lusitanic a. (trace), methyl lusitanate (trace).

DISTRIBUTION AND HABITAT

The species was reported by Hale (1990) from southern and central Europe (France, Italy, Portugal, Romania, Spain and Hungary and from eastern and southern Africa (Giordani & al. 2002). The “Hungarian” collection site [Flora Hungarica, Magas-Tátrában, “Tarpatak” völgyében a 2-ik vizesés – Vysoké Tatry Mts., Malá Studená dolina valley near 2-waterfall - waterfalls stream Studeného potoka near Rainerova lodge (BP 24152T735, holotype of *P. tarpatakensis* Gyeln.)] is, in fact, located in Slovakia. A re-examination of that specimen established that it is in fact *X. conspersa*. *X. verrucigena* was reported from Czech Republic (Suza, 1940; Vězda & Liška, 1999) but the voucher specimen was not located and the species was not recollected at the reported collecting site (Orthová, 2003b).

X. verrucigera is a saxicolous lichen occurring on rock surfaces at an in elevation of 10-80 m. No authentic specimens have been reported from Slovakia.

NOTES

X. verrucigera has rarely branched, verrucose isidia with black, syncorticate apices (Suza, 1940; Hale, 1990) and resembles *X. conspersa*. Chromatography provides the only reliable method for distinguishing these taxa: *X. conspersa* contains stictic and norstictic acids and *X. verrucigera* contains stictic, lusitanic and verrucigeric acids but lacks norstictic acid (Elix & Wardlaw, 2000).

The name *Parmelia verrucigena* was validly published in 1873 not in 1872 (Nylander, Flora 55: 426) as stated both by Hale (1990) and Zahlbruckner (1930).

As the names *Parmelia pseudoservitiana*, *P. servitiana*, *P. pulvinaris* var. *mediterranea* and *P. pseudoservitiana* f. *exornata* were based on single elements they represent holotype specimens (ICBN Art. 9.1 and 9.8) rather than lectotype specimens as designated by Hale (1990).

Parmelia tarpatakensis and *P. isidiigera* f. *ligustica* listed by Hale (1990) as synonyms of *X. verrucigera*, are actually conspecific with *X. conspersa* (see *X. conspersa*).

SPECIMENS EXAMINED

> **Types.** France. "Saxicola. Amélie-les-Bains (Pyrénées-Orientales). Fr. Marc. (Harm. no. 113 as *Parmelia. lusitana*)" (BP 23377T665, holotype of *P. pseudoservitiana* Gyeln.). Monte Negro. "Dalmatia: Hercegnovi, 80 m, 5.1929, leg. Servít, rev. Gyelnik" (BP 21566T703, holotype of *P. servitiana* Gyeln.). Monte Negro. "Dalmatia: Hercegnovi, 10-50 m. Substrat. silic., 5.1929, leg. Servit" (BP 22664T667, mixed with few thalli of *X. conspersa* holotype of *P. pulvinaris* var. *mediterranea* Gyeln.). Romania. "Transsilvania. Domugledicum. Iuxt stationem balnei Herkulesfürdő. Siliceicola, 1935.VII.24., leg. et det. V. Gyelnik" (BP 21567T663, holotype of *P. pseudoservitiana* f. *exornata* Gyeln.).

In total 4 type specimens and 2 exsiccata (Harm. no. 113. as *P lusitana* Saxicola. Amélie-les-Bains (Pyrénées-Orientales). Fr. Marc. (herb. Vězda; BP 23377T665) were studied.

Key to the Slovak species of *Xanthoparmelia*[3]

1a Thallus sorediate, subcrustose	***X. mougeotii***
1b Thallus lacking soredia, foliose	**2**
2a Thallus isidiate, lower surface black	**3**
2b Thallus lacking isidia, lower surface brown or black	**5**
3a Medulla K+ yellow to orange (stictic acid present)	**4**
3b Medulla K+ yellow turns red (salazinic acid present); isidia globose, inflated, pale tipped	***X. tinctina***
4a Isidia cylindrical, simple or coralloid branched; medulla K+ yellow to orange (norstictic acid present)	***X. conspersa***

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[3] based on specimens studied and on data reported by Divakar & Upreti (2002) and Giordani & al. (2002).

4b Isidia verrucose to cylindrical, sparsely branched; medulla K+ persistent yellow (norstictic acid absent, lusitanic and verrucigeric acids present) ***X. verrucigera***[4]

5a Medulla K+ yellow turning red (salazinic acid present) or K-, lower surface pale brown or mottled **6**

5b Medulla K+ yellow to orange (stictic acid present), lower surface black ***X. angustiphylla***

6a Thallus pulvinate, lobes short and densely imbricate, lower surface brown to black, medulla K+ yellow turn red, collected only at high elevation (up 1800 m) ***X. felkaensis***

6b Lobes elongate, dichotomously branched, lower surface pale brown **7**

7a Medulla K+ yellow turning red (salazinic acid present) ***X. somloensis***

7b Medulla K- or K+ brown, P+ yellow turning crimson red (fumarprotoce-traric acid present) ***X. protomatrae***

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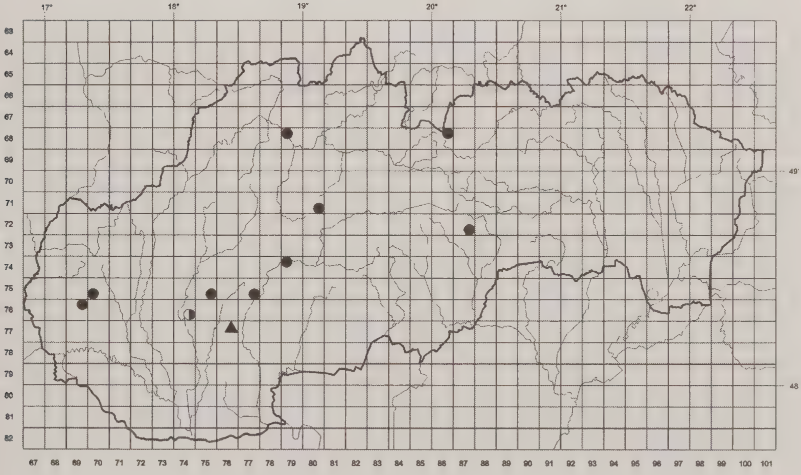
[4] erroneously reported from Slovakia.

Distribution maps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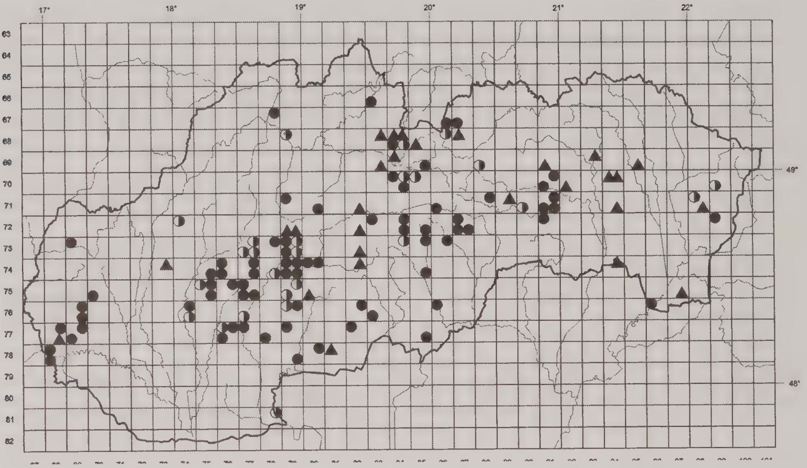
Map 1. Distribution of *Xanthoparmelia angustiphylla* and *X. tinctina*. *Xanthoparmelia angustiphylla* and *X. tinctina* [◑] – specimens examined and published records; *X. angustiphylla* [●] – specimens examined; *X. tinctina* [▲] – specimens examined.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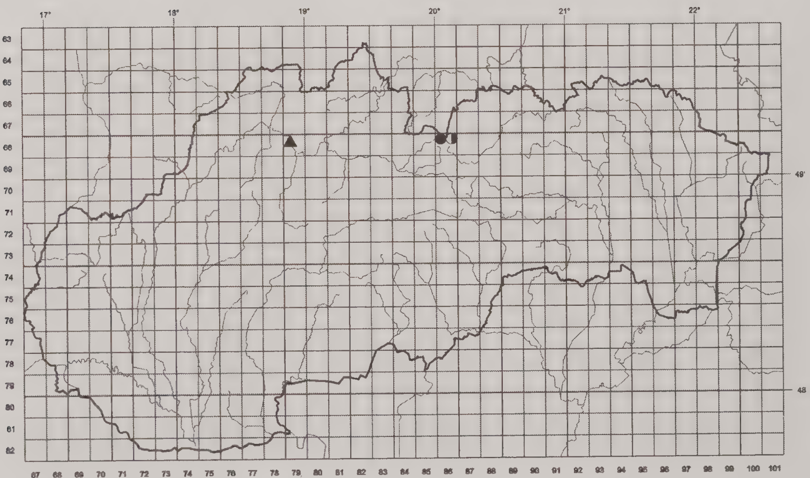
Map 2. Distribution of *Xanthoparmelia conspersa*
[◑] – specimens examined and published records; [●] – specimens examined;
[▲] – published records.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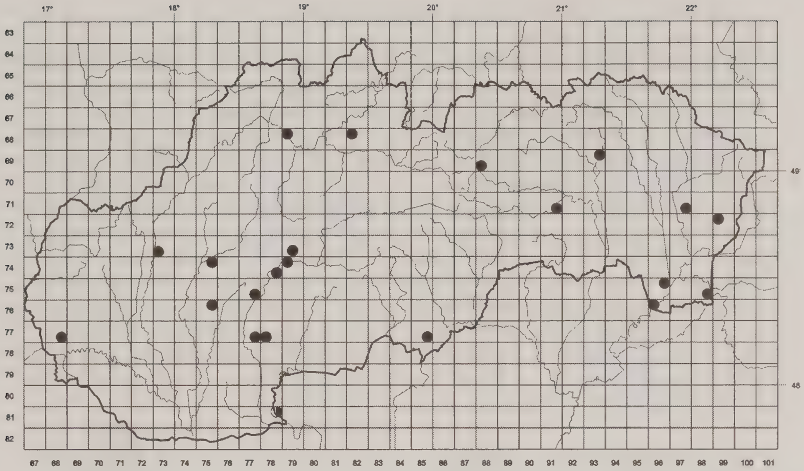
Map 3. Distribution of *Xanthoparmelia felkaensis* and *X. mougeotii*.
Xanthoparmelia felkaensis [◑]– specimens examined and published records;
X. felkaensis [●] –specimens examined;
X. mougeotii [▲] – specimens examined and published records.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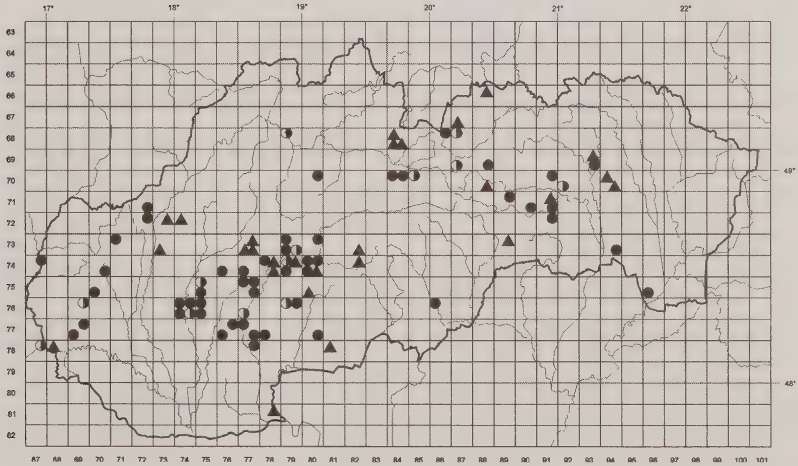
Map 4. Distribution of *Xanthoparmelia protomatrae*
[◑] – specimens examined and published records; [●] – specimens examined.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Map 5. Distribution of *Xanthoparmelia somloensis*
[◑] – specimens examined and published records; [●] – specimens examined;
[▲] – published records.

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A new species and two new records of Ustilaginomycetes from China

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Abstract—A new species, *Urocystis puccinelliae* on *Puccinellia tenuiflora*, is described. Two new species for China, *Urocystis alopecuri* on *Alopecurus* sp. and *Anthracoidea sempervirentis* on *Carex scabrirostris*, are reported.

Keywords—smut fungi, taxonomy

Only one known species of *Urocystis* on *Puccinellia distans* (Jacq.) Parl. and *P. hauptiana* V. Kreecz. has been reported from Russia (Azbukina & Karatygin 1995), which is *Urocystis atropidis* (Lavrov) Zundel (1953) with spore balls measuring 21-22(-31) x 17-24 µm, ustilospores measuring 9-14(-19) x 7-9 µm, and 1-2(-4) ustilospores per spore ball. There is a further species of *Urocystis* on *Puccinellia tenuiflora* collected in the Nei Mongol Autonomous Region, in the Northern part of China, which differs from *U. atropidis* by larger spore balls, broader ustilospores, and more ustilospores per spore ball. It is described as:

Urocystis puccinelliae L. Guo & H. C. Zhang, sp. nov. Figs. 1-2

Sori in foliis et vaginis foliis, primo epidermide obtectas, deinde rupturas. Massa sporarum nigrobrunnea, pulverulenta. Glomeruli sporarum subglobosi, ellipsoidei, ovoidei vel irregulares, 17.5-37.5 x 12.5-31 µm, e ustilosporis 1-4(-5) (numeri ustilosporarum 1=27%, 2=45%, 3=20%, 4=6%, 5=2%) constructi, cellulis sterilibus omnino circumdati. Ustilosporae subglobosae, ellipsoideae, ovoideae vel irregulares, 11.5-20 x 9.5-15 µm, rubrobrunneae vel flavidobrunneae; Cellulae steriles ovoideae, subglobosae vel ellipsoideae, 5-11.5 x 5-7.5 µm, flavidobrunneae; pariete 0.5-1(-2) µm crasso, levi, sub SEM verruculoso.

Sori in blades and sheaths of leaves, at first covered by the epidermis, which later ruptures. Spore mass blackish-brown, powdery. Spore balls subglobose, ellipsoidal, ovoid or irregular, 17.5-37.5 x 12.5-31 µm, composed of 1-4(-5) ustilospores (1=27%, 2=45%, 3=20%, 4=6%, 5=2%; n=100), completely surrounded by sterile cells. Ustilospores subglobose, ellipsoidal, ovoid, or irregular, 11.5-20 x 9.5-15 µm, reddish-brown or yellowish-brown. Sterile cells ovoid, subglobose, or ellipsoidal, 5-11.5 x 5-7.5 µm, yellowish-brown; wall 0.5-1(-2) µm thick, smooth, as seen by SEM (scanning electron microscopy) verruculose.

On *Puccinellia tenuiflora* (Griseb.) Scribn. et Merr. (*Poaceae*), Nei Mongol: Xilin Gol Meng, Zhagesitai Hu, alt. ca. 1000 m, 15 VII 2003, L. Guo, W. Li & H. C. Zhang 2053, HMAS 89268 (holotypus).

On a species of the genus *Alopecurus*, a species of *Urocystis* was discovered in the Xinjiang Uygur Autonomous Region. It is identified as *U. alopecuri*, which is new to China:

Urocystis alopecuri A.B. Frank, Die Krankheiten der Pflanzen. Pilze, p. 440, 1880. Figs. 3-4

Sori in blades and sheaths of leaves, at first covered by the epidermis, which later ruptures. Spore mass powdery, blackish-brown. Spore balls subglobose or ovoid, 18.5-35(-40) x 15-30.5 µm, composed of 1-3 ustilospores (1=69%, 2=28%, 3=3%; n=100), almost completely surrounded by sterile cells. Ustilospores subglobose, ellipsoidal, ovoid, or subpolyhedral, 14-20 x 12-17 µm, brown; wall 0.8-1 µm thick. Sterile cells subglobose, ovoid, or ellipsoidal, 6.5-13 x 5-10 µm, yellow, wall ca. 0.5-1 µm thick, smooth, as seen by SEM verruculose.

On *Alopecurus* sp. (*Poaceae*), Xinjiang: Hejing, Künes Linchang, alt. ca. 2010 m, 16 VIII 2003, L. Guo & H. C. Zhang 2261, HMAS 89267.

So far 43 species of *Urocystis* have been recorded for China, including *U. puccinelliae* and *U. alopecuri* (in this paper).

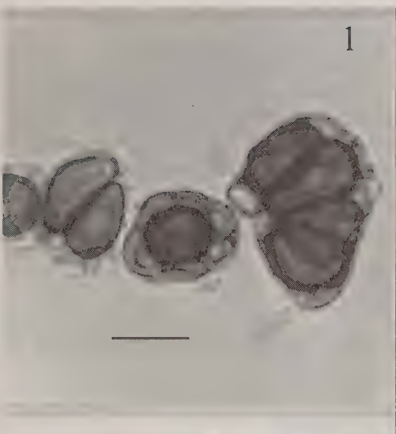
A smut fungus on *Carex scabrirostris* in the section *Frigidae* of the subgenus *Carex* was discovered among unidentified specimens in our herbarium (HMAS). Until now four species of *Anthracoidea* are recognized on species of *Carex* belonging to the section *Frigidae*: 1) *Anthracoidea altera* Nannf. (1979), with ustilospores measuring 16-21 x 15-18 µm, wall ca. 1 µm thick; type on *Carex misandra*, Finland, 2) *Anthracoidea misandrae* Kukkonen (1963), with ustilospores measuring (17-)18-25(-26) x (13-)14-21(-23) µm, wall 0.7-1.5 µm thick, mostly evenly thickened; type on *Carex misandra*, Canada; 3) *Anthracoidea nepalensis* Kakish. & Y. Ono (1988), with ustilospores measuring 14-19 x 11-17 µm, wall 1-1.5 µm thick; type on *Carex nakaona*, Nepal, and 4) *Anthracoidea sempervirentis* Vánky (1979), with ustilospores measuring (16-)19-24(-27) x 14-22 µm, wall 1.5-2.5(-4) µm thick; type on *Carex sempervirens*, Romania.

The fungus on *Carex scabrirostris* in China is identified as *Anthracoidea sempervirentis*, which is new to China (Guo 2000, 2002, 2004; Wang & Piepenbring 2002; Zhang & Guo 2004).

Figs. 1-2. Spore balls of *Urocystis puccinelliae* on *Puccinellia tenuiflora* as seen by LM (light microscopy) and SEM (HMAS 89268, holotypus).

Figs. 3-4. Spore balls of *Urocystis alopecuri* on *Alopecurus* sp. as seen by LM and SEM (HMAS 89267).

Figs. 5-6. Ustilospores of *Anthracoidea sempervirentis* on *Carex scabrirostris* as seen by LM and SEM (HMAS 89270). Bars = 11 µm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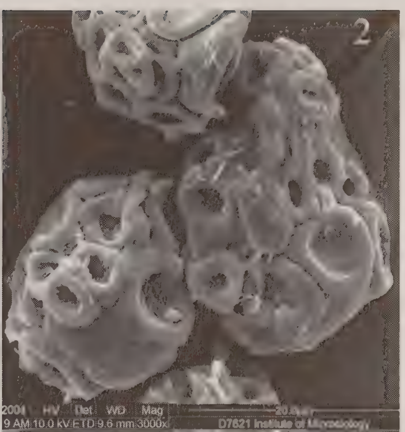
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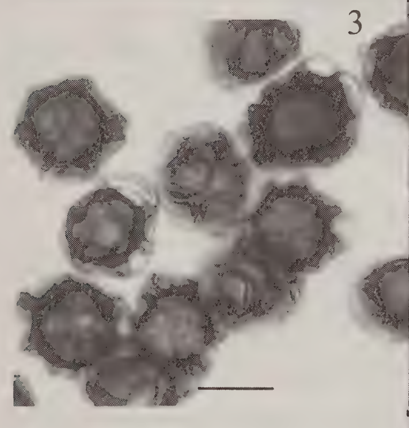
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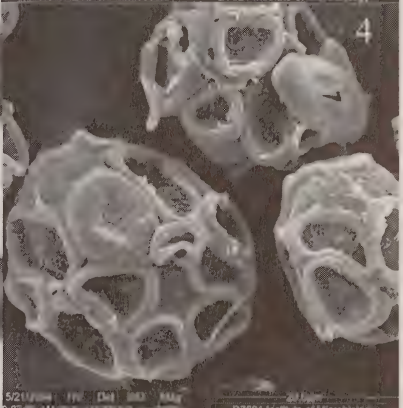
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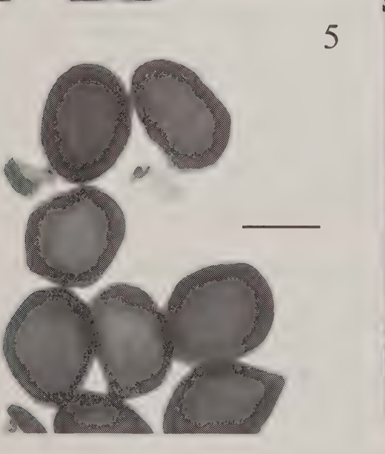
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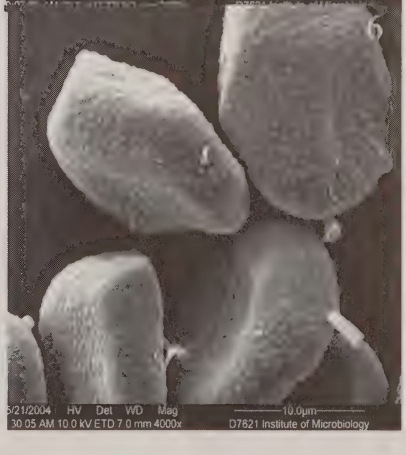
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D7621 Institute of Microbiology

Anthracoidea sempervirentis Vánky, Bot. Not. 132: 225, 1979. Figs. 5-6

Sori in ovaries, subglobose or ovoid, 1.5-2 mm long, 1-1.8 mm wide, at first covered by a grayish, fungal membrane, later exposed. Spore mass black, semi-agglutinated. Ustilospores in plan view ellipsoidal, subglobose, ovoid, or irregular, 16-25 x 12.5-22 µm, in side view 10-15 µm thick, reddish-brown; wall 1.5-2.5(-3) µm, unevenly thickened, thickest at the angles, no internal swellings, sometimes with 1-2 light reflective areas, surface densely verruculose, the warts often confluent as seen by SEM.

On *Carex scabrirostris* Kükenth. (*Cyperaceae*), Shaanxi: Taibai Shan, Sanyehai, alt. 3450 m, 13 VIII 1963, Q. M. Ma & Y. C. Zong 2954, HMAS 89270.

So far 23 species of *Anthracoideae* have been recorded for China, including *A. sempervirentis* (in this paper).

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***Boletus kuthanii*, a new name for *Xerocomus flavus* (*Boletales*)**

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Abstract—For a transfer of *Xerocomus flavus* into *Boletus,* a new name, *Boletus kuthanii,* non *Boletus flavus* With., is proposed.

Key words—boletes, taxonomy

Xerocomus flavus Singer & Kuthan is a rare species with scattered distribution, restricted to thermophilous broadleaved forests in Czech Republic, Bulgaria and probably in Italy (Singer & Kuthan 1976; Engel et al. 1996; Galli 1998). From Bulgaria it has been reported only once by Kuthan & Kotlaba (1989). The species will be proposed for inclusion in the Red List of Bulgarian fungi (in prep.) as a critically endangered (CR) taxon, according to the Red List Criteria of IUCN (2001).

Specimen examined: Bulgaria, prope Primorsko, humi sub Quercubus, 80 m s.m., 16.VI.1976, leg. et det. J. Kuthan (BRA-273!).

According to Kirk et al. (2001) the species of *Xerocomus* Quél. should be placed into the genus *Boletus* Dill. ex L. For the accommodation of *Xerocomus flavus* Singer & Kuthan, as well as in connection with the view of the investigation of Boletales in Bulgaria, a new combination is needed to be proposed. The name *Boletus flavus* is however preoccupied by *B. flavus* With. (Withering 1792). Consequently a new name must be accepted.

Boletus kuthanii Assyov & Denchev, **nom. nov.**

≡ *Xerocomus flavus* Singer & Kuthan, Česka Mykol. **30**: 153 (1976), non *Boletus flavus* With., Bot. Arr. Brit. Pl. **3**: 415 (1792), q.e. *Suillus grevillei* (Klotzsch : Fr.) Singer, nec *Boletus flavus* Pollini, Fl. Veron. **3**: 607 (1824), q.e. *Inonotus hispidus* (Bull. : Fr.) P. Karst.

Holotype: Southern Moravia, Zdravá Voda, Ždanický les, 4.VIII.1974, leg. K. Kříž & R. Singer (F-C5759, n.v.).

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A new species of *Leucocoprinus* from India

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Abstract—*Leucocoprinus lacrymans sp.nov.* is described, illustrated and discussed based on collections made in Kerala State, India.

Keywords—*Agaricaceae, Agaricales*, Basidiomycota

Introduction

Leucocoprinus Pat. (*Agaricaceae, Agaricales*, Basidiomycota) has been accepted by Singer (1986) and many other authors as a genus distinct from other closely related genera of the tribe *Leucocoprineae* Singer like *Macrolepiota* Singer and *Leucoagaricus* (Locq.) Singer. According to Singer (1986), the genus occupies a position intermediate between *Macrolepiota* and *Leucoagaricus*. The generally small-sized basidiomata and the absence of clamp-connections differentiate *Leucocoprinus* from *Macrolepiota*, while it can be distinguished from *Leucoagaricus* by the fragile coprinoid basidiomata, the plicate-sulcate-striate pileal margin, the relatively large cheilocystidia, and the abundance of pseudoparaphyses (pavement cells) in the hymenium. Reports from around the world reveal its cosmopolitan but predominantly tropical distribution. Singer (1986) recognized 13 species as belonging to the genus while several new species were described later (e.g., Migliozzi *et al.* 1989; Reid 1989, 1990). Manjula (1983) listed 5 species as known from India. During our studies on the lepiotaceous fungi of Kerala State, a new species of *Leucocoprinus* was discovered and is described below.

Materials and Methods

Microscopic observations were made on material mounted in 3% aqueous KOH. Colour codes refer to Kornerup & Wanscher (1978). All collections examined are deposited in the National Herbarium of the Netherlands, Leiden (L).

Description of new species

Leucocoprinus lacrymans T. K. A. Kumar & Manim. *sp.nov.* **FIGURE 1**
Etymology: *lacrymans* (L), weeping

Basidiomata exsudato-punctata, ubi contusus pallide rubro-brunnea. Sporae 5-13 x 4.5-11 µm, late ellipsoideae, ovoideae vel subglobosae, poro germinativo instructae.

> *Cheilocystidia 10-126 x 4-8 µm, anguste cylindrica vel flexuosa, ad apicem obtusa. Pleurocystidia nulla. Pileipellis e vallo trichodermiali efformata; elementae terminalis 60-125 x 4-8 µm, erectae vel suberectae, cylindricae vel flexuosae, ad apicem obtusae, tenuitunicatae, brunneae. Hyphae omnes defibulatae.*

Basidiomata small to somewhat large and robust, all parts turning greenish gray (28D2) on reaction with ammonia fumes and pale reddish brown (8D8) on bruising. **Pileus** 3-8.3 cm diam., at first truncate-cylindrical, then conico-campanulate to convex, finally becoming applanate often with a more or less distinct obtuse umbo; surface white, dotted with minute, appressed, cinnamon (6D6) to rust brown (6E8) squamules that are denser towards the umbo and sparse towards the margin, densely granulose-squamose to somewhat velutinate at the umbo; sulcate-striate towards margin, beaded with golden yellow (5B7) to reddish brown (8D8) watery exudates; margin entire, initially incurved and entire, becoming plane and fissile with age. **Lamellae** free but not attached to a collarium, moderately crowded, ventricose, thin, up to 4mm wide, initially white, turning yellowish white (1A2), finally reddening with age or on drying, with lamellulae of two to three lengths; edge finely fimbriate, tinted grayish on mature specimens. **Stipe** 4-12 x 0.5-0.6 cm, central, terete, almost equal or slightly tapering towards the apex, hollow; surface white to orange white (5A2, 5A3), darkening (6E6, 6E7, 7D5) with age, rather velutinous to villose when young, somewhat appressed-fibrillose when old, beaded with golden yellow (5B7) to reddish brown (8D8) watery exudates; base with white mycelial cords. Annulus superior, white, membranous, evanescent, usually disrupting without trace. **Context** up to 3 mm thick, initially white, turning orange white (5A2) to pale orange (5A3) and finally grayish orange (5B3, 5B4) on prolonged exposure, **Odour** not distinctive. **Spore-print** white.

Spores 5-13 x 4.5-11 (8.63±1.84 x 6.5±1.37) µm, Q = 1.0-1.6, Qm = 1.33, broadly ellipsoid, ovoid or subglobose, with a distinct germ-pore (up to 1.5 µm broad), hyaline, with refractive guttules and a thick complex wall, smooth, dextrinoid, distinctly metachromatic in cresyl blue. **Basidia** 20-28 x 8-12.5 µm, clavate to broadly clavate, with guttulate contents, bearing four sterigmata less than 4 µm long, surrounded by pseudoparaphyses. **Lamella-edge** sterile. **Cheilocystidia** 10-126 x 4-8 µm, narrowly cylindrical to flexuose, with an obtuse apex, often in tufts, thin-walled, hyaline or with pale to dark brown contents. **Pleurocystidia** absent. **Lamellar trama** regular, of thin-walled, hyaline hyphae, 3-7 µm wide, inflated up to 24 µm. **Pileal trama** interwoven: hyphae 3-20 µm wide, thin-walled, hyaline, inamyloid. **Pileipellis** a disrupted cutis with trichodermial patches of ascending or erect elements, 60-125 x 4-8 µm, narrowly cylindrical or somewhat flexuose, with obtuse tips, thin-walled, with brown granular contents; entirely trichodermial at the disc. **Stipitipellis** a disrupted cutis of thin-walled, hyaline to gray-colored hyphae with trichodermial patches of ascending or erect elements; terminal elements up to 100 µm long, 2-5 µm wide, narrowly cylindrical to somewhat flexuose, with obtuse apices. All hyphae lack clamp-connections.

Habitat: On soil and decaying leaf litter around the base of coconut trees, solitary or in clusters.

Known distribution: Known only from the type locality

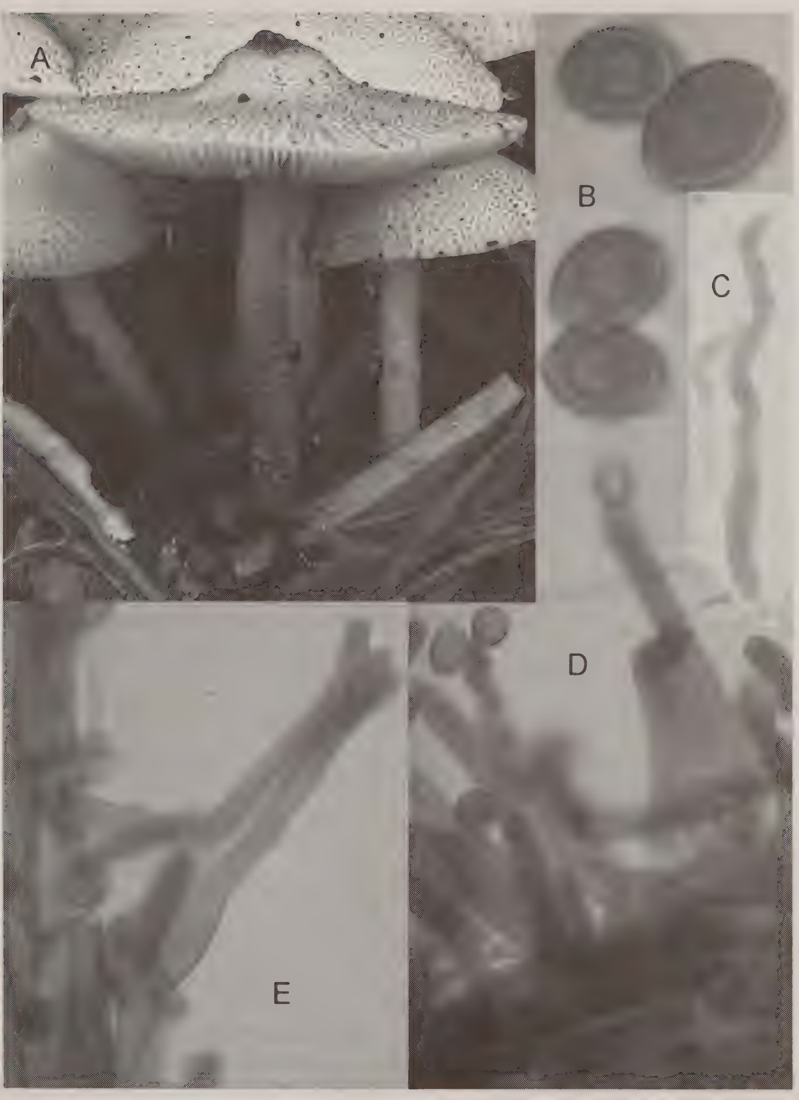

Fig. 1. *Leucocoprinus lacrymans*: A, basidiomata, x 1; B, spores, x 2000; C, cheilocystidium, x 650; D, pileipellis, x 650; E, stipitipellis, x 650

COLLECTIONS EXAMINED — INDIA, Kerala State, **Calicut District,** calicut: 28 August 2003, Arun Kumar AK1; 9 April 2004, Arun Kumar AK17 (**holotype**); 11 April 2004, Arun Kumar AK17a; 27 April 2004, Arun Kumar AK18; 27 April 2004, Arun Kumar AK18a; 28 April 2004, Arun Kumar AK18b; 4 May 2004, Arun Kumar AK18c; 8 May 2004, Arun Kumar AK18d (all at L).

Discussion

Leucocoprinus lacrymans is characterized by small to medium-sized whitish basidiomata dotted with fine brownish squamules and drops of golden yellow to reddish brown exudates, greenish gray coloration of basidiomata on reaction with ammonia fumes, gradual color change to pale reddish brown on bruising, a white context turning orange white to pale orange and finally grayish orange on prolonged exposure, spores showing a wide range of size and shape, conspicuously elongate and flexuous cheilocystidia, and cylindrical pileipellis elements. Larger spore dimensions, exceeding 8(9) x 6 μm, and distinct germ-pore indicate that it belongs to the section *Cepaestipedes* Konrad & Maubl. It is clearly related to the *Leucocoprinus badhamii* complex (Reid, 1990) comprising species which redden on bruising or become green in ammonia fumes. The closest in the complex seems to be *Leucocoprinus meleagris* (Sowerby) Locq., known to be widely distributed in both temperate and tropical regions (Reid, 1990; Pegler, 1977, 1983; Manjula, 1983). These two species have a number of macroscopical and a few microscopical similarities including the size and shape of spores. However, the shape of cheilocystidia, caulocystidia and the elements comprising the scales of the pileus in *Leucocoprinus lacrymans* is always cylindrical while it is never cylindrical but clavate, fusoid or lanceolate often with a distinct apical prolongation in *L. meleagris*. Also, on bruising, the basidiomata of *L. lacrymans* turn pale reddish brown while those of *L. meleagris* turn intensely red. On exposure, the context of *L. lacrymans* changes colour from white through orange white to pale orange while that of *L. meleagris* discolours through lemon yellow to orange red. In addition, the basidiomata of *L. lacrymans* always exude droplets of a golden yellow to reddish brown watery fluid, a feature not known in *L. meleagris* and related species. The Sri Lankan species, *Leucocoprinus holospilotus* (Berk. & Broome) D.A. Reid and *Leucocoprinus biornatus* (Berk. & Broome) Locq., which according to Reid (1990) are microscopically indistinguishable from each other and are closely related to *L. meleagris*, are characterized by unchanging colour of flesh, smaller spore dimensions, clavate or broadly lanceolate cheilocystidia with a mucronate apex and pileal scales comprising of short ovate or broadly lanceolate cystidiiform elements. *Leucocoprinus caldariorum* D. A. Reid, another species similar in appearance and habitat to *L. meleagris*, has a well-developed spreading annulus, broadly amygdaliform spores, ovate, clavate or lanceolate cheilocystidia frequently with apical prolongation and pileal surface with numerous short and squat hairs.

Species belonging to the so-called '*badhamii*-complex' have been shuttling back and forth between *Leucoagaricus* and *Leucocoprinus* (*cfr* Moser 1983 and Reid 1990 with Bon 1993 and Vellinga 2001). We prefer to consider the new species from Kerala as belonging to *Leucocoprinus* because of the abundant development of pseudoparaphyses in the hymenium. Although a recent molecular study (Vellinga, 2004) questions the validity of it, we believe that this character is very useful to differentiate between *Leucocoprinus* and *Leucoagaricus* as long as we stick to the traditional morphology-based classification.

Acknowledgements

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A multiple approach to the taxonomy of *Lactarius rubrozonatus* (Basidiomycota, *Russulales*)

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Abstract - The biometric and molecular data supporting the separation of the new taxon *Lactarius rubrozonatus* from *L. sanguifluus* are discussed. The results of a multidisciplinary examination led to separate two close taxa growing sympatrically in symbiotic association with two-needle pines. Even though, morphologically, the only reliable separating characters were pileal zonation and spore size, the autonomy of the new taxon was supported by ITS sequences and the stop of genetic flux in five allozymes. The new taxon, which was previously referred to as *L. vinosus*, was renamed *L. rubrozonatus* because the older epithet was illegitimate.

Key Words - Cryptic speciation, ectomycorrhizal fungi, *Lactarius* section *Dapetes*

Introduction

In the genus *Lactarius* Pers. (*Russulales*, *Basidiomycota*), members of the section *Dapetes* Fr., with mild, red-coloured latex, are ranked among the most prized edible fungi by mushroom hunters. In fact, they are gathered and marketed in many countries, especially in the Mediterranean area, where evidence of this interest dates from Roman frescos and mosaics (Ainsworth 1976).

Lactarius sanguifluus (Paulet : Fr.) Fr., probably the most valued species of this group, grows in symbiosis with some two-needle species of *Pinus*, mainly in South Europe. Its basidiomata exude vinaceous-red latex and show an impressive phenotypical variability, often showing overlapping characters, apparently without further microanatomical differences (Lalli & Pacioni 1982). Unfortunately, this rather complex taxonomic situation is compounded by the nomenclatural problems regarding *Lactarius vinosus* Quél., for which several conflicting descriptions have been published (Blum 1976; Marxmüller & Romagnesi 1991; Courtecuisse & Duhem 1994; Moser & Jülich 1996; Basso 1999), without any reference to types specimens.

Recently (Lalli, Frizzi & Pacioni 2002), a check of populations of *Dapetes* from central Italy, by means of horizontal starch gel electrophoresis of enzymes, has enabled the separation of *Lactarius sanguifluus* into two genetic groups, one of which was provisionally labelled as "*Lactarius vinosus*". Given the strong evidence for the existence of two distinct taxa, there remained to be solved the nomenclatural problems connected with the epithet *vinosus*. A close scrutiny of these problems revealed that *L. vinosus* was illegitimate (Lalli, Pacioni & Leonardi 2002) and led us to propose a neotypification for *Lactarius sanguifluus* and the new name *L. rubrozonatus* Lalli & Pacioni.

Here, we present further biometric and molecular evidence that support the taxon *Lactarius rubrozonatus*.

Materials and Methods

Specimens

The study was carried out on the dried and frozen specimens already used for the electrophoretic survey on the *Dapetes* (Lalli, Frizzi & Pacioni 2002). Among these, the attention was focused on the 89 specimens referring to different phenotypes of *Lactarius sanguifluus* [typical, grey-violaceous form (= *Lactarius vinosus* ss Blum 1976; Marxmüller & Romagnesi 1991) and an undescribed pinkish form] which exhibited nil genetic distance, and the 47 specimens of both the typical *Lactarius vinosus* ss Courtecuisse & Duhem (1994); Moser & Jülich (1996); Basso (1999), now *L. rubrozonatus*, and a flesh-coloured form with nil genetic distance.

All specimens were collected beneath *Pinus nigra* Arnold or *P. silvestris* L. stands in the Abruzzi, central Italy, and their vauchers are preserved in the Herbarium Mycologicum Aquilanum (AQUI).

Morphology

Microanatomical features were studied with light and scanning electron microscopy. In particular, pseudo-, cheilo- and pleurocystidia, basidia, hymenial trama, pileipellis and stipe cortex were examined using H_2O, KOH 5%, NH_4OH and Melzer, Congo Red, Blue Cotton, Sulphoanylin, Sulphoformol micro-reactions. For each specimen, 10 spores, mounted in KOH, were measured at a magnification of x1000.

Spores from dried herbarium specimens were suspended in distilled water and a drop was put on acetone washed aluminium stubs and then dehydrated in a dessiccator under vacuum with silica gel over night. Samples were coated with a gold layer 200 Å thick in a sputter coater (Agar Auto Sputter Coater) and observed with a Philips XL30CP SEM, at 15 kV.

Table 1. Starch Gel Electrophoresis conditions for detection of allozymes

Abbr.	Enzymes	Buffer *	pH	E. C. N. **	References
MDH	Malate dehydrogenase	1	8.2	1.1.1.37	Shaw and Prasad (1970)
ICD	Isocitrate dehydrogenase	1	8.2	1.1.1.42	Brewer and Sing (1970)
HK	Hexokinase	3	8.0	2.7.1.1	Harris (1966)
AK	Adenylate kinase	2	7.2	2.7.4.3	Brewer and Sing (1970)
PGM	Phosphoglucomutase	2	7.2	2.7.5.1	Brewer and Sing (1970)

* *Buffer systems used: 1) Lithium/borate; 2) Tris/maleate; 3) Tris/versene/borate;*
** *E.C.N.: Nomenclature Committee of the International Union of Biochemistry.*

Starch gel electrophoresis

Homogenates, absorbed in 5 by 5 mm pieces of chromatography paper (Watmann 3MM), were inserted in 10.5% Connaught hydrolyzed horizontal starch gel trays, according to Pacioni & Pomponi (1989).

The electrophoresis (SGE) was conducted at a constant 8 v/cm for 3 h at 4 °C.

According to previous experiences (Pacioni & Pomponi 1989, 1991; Pacioni *et al.* 1993), the specific stainings were done in accordance with Brewer & Sing (1970), Harris (1966), Shaw & Prasad (1970) and the conditions are shown in Table 1, where the list of the enzymatic loci studied with details on the techniques are given.

Six previously identified allozymes: MDH (malate dehydrogenase), ICD (isocitrate dehydrogenase), HK (hexokinase), AK (adenylate kinase), PGM (phosphoglucomutase) and MPI (mannose phosphate isomerase) were comparatively studied.

The mobility of enzymes of the *L. sanguifluus* specimens from S. Lorenzo, Poggio di Roio, L'Aquila, was used as a standard, the mobility of the commonest alleles in this population was taken as 100.

Molecular analyses

Genomic DNA was isolated from small amount of dried and fresh basidiocarps (20-35 mg). The material was ground to a fine powder using a sterilized mortar and liquid nitrogen; than DNA was extracted following the protocol of Bruns *et al.*(1990), checked on a 1% agarose gel and visualized by staining with ethidium bromide. We used the ITS1F and ITS4 oligonucleotide primers (Gardes & Bruns 1993), READYMIX REDTAQ PCR REACTION MIX (SIGMA) for PCR amplification. The cycling parameters were: an initial denaturation at 94°C for 3 min; 35 cycles consisting of 25 s at 95°C, 55 s at 53°C, 2 min at 72°C; and a final extension step for 7 min at 72°C. Negative controls (no DNA template) were included in every experiment. The PCR products were purified using the GenElute™ PCR DNA Purification Kit (SIGMA) and quantified by 2% agarose gel electrophoresis. The DNA templates were directly sequenced using ABI PRISM™BigDye™ Terminator Cycle Sequencing reaction kit (Applied Biosystems), according to manufacturer's protocol, and ABI 377 automated sequencer (Perkin Elmer).

Table 2. Accession numbers of reference sequences.

Species	Country	Vouchers	GenBank acc. no.
Lactarius controversus	Hungary:Nagykoros	Strain 98/33	AJ272246
Lactarius deliciosus	France	Strain D39 clone b	AF249284
Lactarius deterrimus	Germany:Voehrenberg	Ursula Eberhardt ue166	AF140267
Lactarius quieticolor	Germany:Kiebingen	Ursula Eberhardt ue141	AF140269
Lactarius salmonicolor	Germany:Voehrenbach	Ursula Eberhardt ue158	AF140265
Lactarius sanguifluus	France	Strain S22	AF249289
Lactarius sanguifluus	France	Strain S38 clone a	AF249290
Lactarius sanguifluus	France	Strain S38 clone b	AF249291
Lactarius semisanguifluus	Germany:Tuebingen	Ursula Eberhardt ue149	AF140268
Lactarius subsericatus	Germany:Zierenberg	Ursula Eberhardt us95/13a	AF140261
Russula delica	Spain	Strain Rd	AF096987

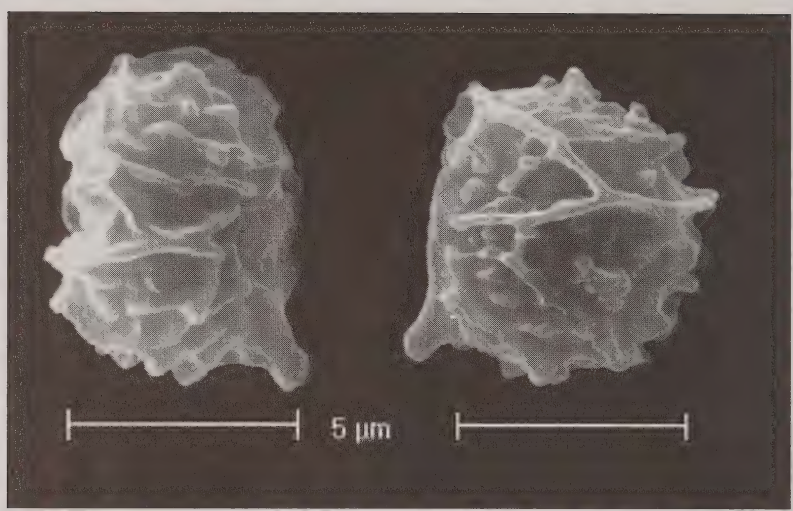

Fig. 1.SEM micrographs of two representative *Lactarius rubrozonatus* (left) and *L. sanguifluus* (right) spores.

Data treatment

Preliminary multiple alignments were generated using Clustal X (Thompson *et al.* 1997) and manually optimized; ambiguous regions were excluded from subsequent analyses. Phylogenetic analyses were conducted using MEGA Software (http://www.megasoftware.net). Eight additional sequences used in this study were retrieved from GenBank; the collections are listed in Table 2 with their GenBank accession number (*Russula delica* Fr. represents an outgroup). Three available sequences of *Lactarius sanguifluus,* also in Table 2, were preliminarily tested with BLAST against our specific sequences.

Maximum parsimony analyses were performed in MEGA selecting the "pairwise delection" mode to consider delections. The initial region (1-50) and the final (782-) were excluded.

The statistical analyses of the morphological character dimensions were performed by the packages S-plus®2000 software (Insightful Corporation – Seattle) and Statistica for Windows® rel. 5.5 (StatSoft.Inc) .

Results

Of all the macro- and microscopic morphological characters taken into consideration, only the cap zonature (continous in *L. rubrozonatus*, absent or spotted in wet *L. sanguifluus*) and spore morphology (Fig. 1) seemed to be distinctive whereas all the others appeared to be useless. Recently, Nuytinck & Verbeken (2003), dealing with the same taxa, have pointed out some morphological diagnostic differences between them. *L. vinosus* (= *L. rubrozonatus*) exhibits only vinaceous red tinges without the orange shades occurring in *L. sanguifluus*, and it has a more marked tapering of stipe,

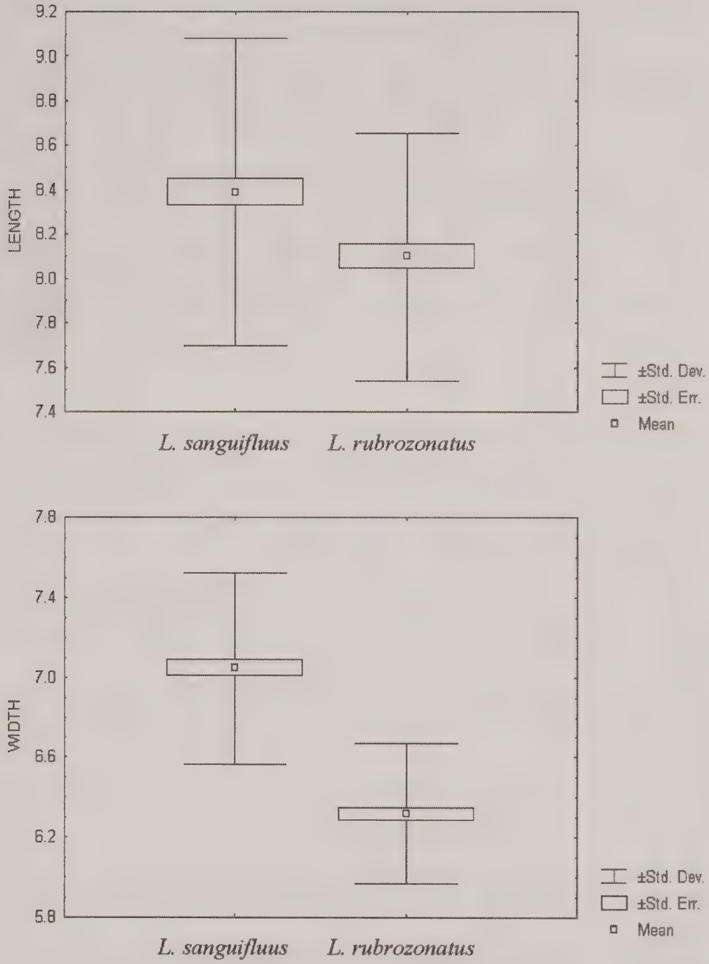

Fig. 2. Box & Whisker Plots comparing mean length (p-value= 0.0019) and width (p-value= 0.00001) of *Lactarius sanguifluus* and *L. rubrozonatus* spores.

a stronger red colour in the cap flesh, and a less complete sporal reticulum. In our opinion, of the above diagnostic features, the validity of which was previously critically examined by us (Lalli & Pacioni 1982; Lalli, Pacioni & Leonardi 2002), only spore ornamentation might be regarded as an additional separating character, but it is of difficult handling, based as it is on small differences in the thickness of the ridges of the reticulum: thinner in *Lactarius rubrozonatus*. The spore size range (length and width) of two taxa could apparently seem overlapping being 6.0-10.8 x 6.0-9.2 μm in *L. sanguifluus* and 6.8-9.6 x 5.2-7.2 μm in *L. rubrozonatus*. However, small but constant differences are found when they are processed separately (Table 3).

Table 3. Confront of *L. rubrozonatus* and *Lactarius sanguifluus* spore sizes. Means with standard deviation.

	length	**mean**	**width**	**mean**	**L/W mean**
L. rubrozonatus	6.8-9.6 μm	8.10 ± 0.56	5.2-7.2 μm	6.32 ± 0.35	1.28 ± 0.09
L. sanguifluus	6.0-10.8 μm	8.39 ± 0.69	6.0-9.2 μm	7.05 ± 0.95	1.19 ± 0.08

In Fig. 2, two Box & Whisker plots, the spore size observed in the two taxa are shown. The t-test demonstrates that the two distributions are statistically well separated for the length (p-value= 0.0019) and width (p-value= 0.00001) of spores, and indeed the ratio L/W values also appear to be significantly different. The spores of *Lactarius sanguifluus* are slightly wider than those of *L. rubrozonatus*.

Table 4 shows allele frequencies for some of the scored allozymes. These data, which concern seven loci (*Mdh-1*, *Mdh-2*, *ICD*, *HK-1*, *AK*, *PGM*, *MPI*), suggest that these alleles are not shared and consequently any genetic flux between the two taxa is clearly stopped. The two taxa are indeed genetically separated.

The ITS sequences of the two taxa result about 700-718 bp long and are deposited in GenBank under accession number: AY292987 (*L. rubrozonatus*), AY296130 (*L. sanguifluus*).

Comparison of our specimens with the sequences of *Lactarius sanguifluus* available in GenBank (Table 2), resulted in complete agreement, with identity values of 98-99%, so confirming the validity of our taxonomic concept.

The elaboration of the data yielded three equally parsimonious trees. The trees have rather low bootstrap values probably because of the poorly informative sites that can be used.

Although sequences seem to be very similar, there are constant differences, especially in the region positioned after the start of ITS1, which support the separation of the two species from a molecular point of view.

The results of these analyses are presented by a consensus diagram obtained from the three most parsimonious trees (Fig. 3). On the grounds of the bootstrap value the two taxa are very close, nevertheless the value is the same as that found between *Lactarius deliciosus* and *L. quieticolor*.

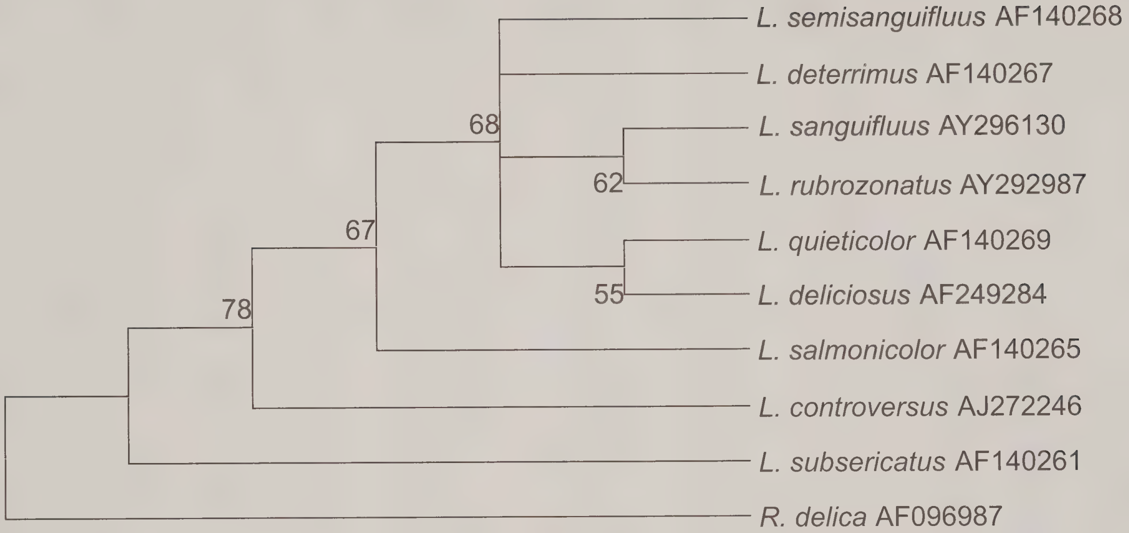
L. semisanguifluus AF140268
L. deterrimus AF140267
L. sanguifluus AY296130
L. rubrozonatus AY292987
L. quieticolor AF140269
L. deliciosus AF249284
L. salmonicolor AF140265
L. controversus AJ272246
L. subsericatus AF140261
R. delica AF096987
68
62
67
55
78

Fig. 3. Consensus tree, based on ITS sequences of 9 taxa of *Lactarius* (7 of the section *Dapetes*). On the tree nodes the boot straps value. *Russula delica* represents an outgroup.

This multiple taxonomic approach has confirmed the existence of two different taxa, distinct from a morphological, genetic and molecular point of view, within the populations symbionts of two-needle pines with vinaceous-red latex, generally ascribed to *Lactarius sanguifluus*.

Table 4. Allele frequencies. Sample sizes (*N*) and allelic mobility relative to the most common alleles are also shown

	L. sanguifluus	***L. rubrozonatus***
Mdh-1	***Malate dehydrogenase***	
(*N*)	*70*	*37*
96/96	--	100
100/100	100	--
Mdh-2		
(*N*)	*69*	*41*
87/92	--	29.3
92/92	--	70.7
100/100	100	--
ICD	***Isocitrate dehydrogenase***	
(*N*)	*84*	*29*
100/100	100	--
103/103	--	100
HK-1	***Hexokinase***	
(*N*)	*89*	*32*
96/96	2.3	--
96/100	25.8	--
100/100	71.9	100
AK	***Adenylate kinase***	
(*N*)	*68*	*44*
94/100	100	27.3
100/100	--	72.7
PGM	***Phosphoglucomutase***	
(*N*)	*89*	*46*
96/100	31.5	100
100/100	68.5	--
MPI	***Mannose phosphate isomerase***	
(*N*)	*83*	*41*
91/97	--	17.1
94/94	47.0	82.3
94/100	38.5	--
100/100	14.5	--

Discussion

The taxa of the section *Dapetes* have generally been separated on the basis of latex. basidioma colours and host trees, because the micromorphological characters are rather poor and of little help for taxonomy. Being species of economical interest both as ectomycorrhizal forestry fungi and food all over the northern hemisphere, additional tools for their identification are necessary.

The two examined taxa, indeed, have a strong morphological similarity, with overlapping characters, and only a small but significant difference in spore size, which is difficult to detect because of an apparent overlapping of their ranges. Quite surprisingly, however, there exists a clear genetic distance due to a reproductive segregation without genetic flux for some genes that undoubtedly discriminates the two taxa, and this separation is reinforced by the dissimilarity at ITS sequence level.

The allozyme data directly show an amphimictic dikaryotic system of reproduction, because of heterozygosity. These two taxa were found to grow sympatrically with *Pinus nigra* and *P. silvestris*. These results could show probably a case of cryptic speciation involving ectomycorrhizal fungi with an amphimictic system of reproduction. Previously the existence of a number of sibling taxa within one same morphotype was shown with the ectomycorrhizal genus *Tuber* Fr. (Pacioni & Pomponi 1991; Pacioni et al. 1993; Urbanelli et al. 1998), however the species of this genus seem to be homokaryotic and, perhaps, automictic, with a permanent binucleate mycelium (Bertault et al. 1998; Frizzi et al. 2001).

On the basis of these results, a re-examination of *L. sanguifluus* collections growing in association with other two-needle pines in southern Europe (including northern Africa and the Middle East) would seem to be in order (Lalli & Pacioni 1982).

Acknowledgements

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The genus *Tulostoma* in Sonora, Mexico

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Abstract — Seventeen species of *Tulostoma* from 92 collections found in Sonora (Mexico) were studied. Four species: *Tulostoma cyclophorum, T. floridanum, T. involucratum,* and *T. squamosum* are new records for Mexico. Most of the studied material was collected in microphyllous desert scrub and tropical thorn forest during summer and winter. *Tulostoma fimbriatum* was the only species observed in arid, semiarid and temperate areas. *Tulostoma floridanum* and *T. squamosum* showed a restricted distribution in tropical deciduous forest. SEM photographs of spore ornamentation are provided.

Key words — chorology, spore ornamentation, SEM, taxonomy, *Tulostomataceae*

The great biodiversity existing in Sonora has justified the protection of several important reserves in this Mexican state: Upper Gulf of California and Colorado River Delta Biosphere Reserve, including wetlands and estuaries; Pinacate and Grand Desert of Altar Biosphere Reserve, located in a xeric area; Reserve for the Protection of Flora and Fauna Álamos-Cuchujaqui River, with tropical deciduous forest; Ajos-Bavispe National Forest Reserve and Wildlife Refuge, with pine-oak forest.

Sonoran tropical deciduous forest is important as it represents the northern limit of that type of vegetation in the American Continent, being the habitat for certain mushrooms, such as *Rugosospora pseudorubiginosa* (Cifuentes & Guzmán) Guzmán & Band.-Muñoz and *Humphreya coffeata* (Berk.) Steyaert, which are mainly distributed in South America (Esqueda et al. 1999). Little known *Tulostomataceae* have been found in the Sonoran desert, i.e. the genera *Battarreoides* T. Herrera and *Chlamydopus* Speg. (Esqueda et al. 1998b).

Up to the present time only seven species of *Tulostoma* have been cited from Sonora. One of them, *T. portoricense* J.E.Wright, is known only from the holotype from Puerto Rico (Wright 1987) and one collection from Sonora at worldwide level (Esqueda et al. 1998a). *Tulostoma xerophilum* Long is restricted to North America (Wright 1987). *Tulostoma albicans* V.S.White, *T. nanum* (Pat.) J.E.Wright and *T. occidentale* Lloyd (Wright et al. 1972; Guzmán 1975) are critical or ill-defined species, which require further studies to establish their taxonomic position. On the contrary, two other species previously recorded from Sonora, *Tulostoma fimbriatum* Fr., and *T. striatum* G. Cunn. (Wright et al. 1972; Aparicio-Navarro et al. 1994) have been cited in numerous localities around the world.

The diversity of mushrooms from Sonora is clearly pointed out in the present paper. Seventeen species of *Tulostoma* were studied, four of which are new records for the Mexican mycobiota. Material was collected in microphyllous desert scrub, tropical thorn forest, tropical deciduous forest, oak woodland and *Quercus-Juniperus-Pinus* forest.

Material and methods

Studied material was collected in field trips through several localities of Sonora during the last 12 years. The collections have been deposited in the National Herbarium of the Institute of Biology, UNAM (MEXU), the mushroom collection of the "Centro de Estudios Superiores del Estado de Sonora" (CESUES) and the herbarium of the University of Alcalá, Spain (AH). Spore ornamentation of all collections has been studied under SEM according to Moreno et al. (1995).

Taxonomy

Tulostoma albicans V.S. White, *Bull. Torrey Bot. Club* 28: 428. 1901.
(Fig. 1)

Material studied: Agua Prieta municipality, Km 4 Agua Prieta to Nacozari road, E. Herrejon, 13-VIII-1991, CESUES 27. La Colorada municipality, Km 31 Hermosillo to Yécora road, M. Esqueda, A. Armenta A. Núñez & R. Santos, 11-IX-1996, AH 31747 ex CESUES 2794. Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta A. Núñez & R. Santos, 16.II.1996, CESUES 2369. Ibidem, 17-III-1996, CESUES 2619. Soyopa municipality, Km 162.5 Hermosillo to Yécora road, M. Esqueda, A. Armenta A. Núñez & R. Santos, 22-II-1998, CESUES 3698.

REMARKS: *Tulostoma albicans* is recognized by its exoperidium being thinly but clearly membranous, mouth circular and spores smooth to minutely asperulate. Under SEM the ornamentation appears as small and irregular verrucae, some anastomosed.

We agree with the opinion expressed by Wright (1987) regarding the taxonomic problems related to *T. albicans* concept. Definitively, this taxon is ill defined. Specifically, there are two species close to *T. albicans*: *T. moravecii* Pouzar and *T. xerophilum* Long. These are so similar that even the study of their spore ornamentation under SEM fails to contribute sufficient differences: all of them show spores with similar irregular verrucae. The differentiation between *T. albicans* and *T. xerophilum* is especially problematic since they share a similar distribution area in North America (*T. moravecii* shows an European distribution). Therefore, additional exhaustive studies on North American collections of these species are needed to clarify their taxonomic situation definitively.

Tulostoma albicans has been cited from USA and Mexico (Baja California, Coahuila, Distrito Federal, Durango, Nuevo León, San Luis Potosí, Sonora, Tamaulipas) (Guzmán & Herrera 1969; Wright et al. 1972; Rodríguez-Scherzer & Guzmán-Dávalos 1984; Wright 1987; Guzmán et al. 1992; Moreno et al. 1995). It was observed in summer and winter in microphyllous desert scrub and tropical thorn forest in Sonora. In addition, this species has been collected outside of North America in Argentina, Spain, Sweden and Australia (Wright 1987). Several of these records have been already corrected (Altés 1996; Altés et al. 1996), the rest being somewhat doubtful, in our opinion.

Tulostoma beccarianum Bres. *in* Petri, *Ann. Mycol.* 2: 413-414. 1904.
= *T. simulans* Lloyd, *The Tylostomeae* p.18. 1906.

(Fig. 2)

Material studied: Baviácora municipality, Mazocahui, M. Esqueda & J. Jiménez, 26-III-1993, AH 31748 ex CESUES 1213b. Hermosillo municipality, Ejido Guadalupe Victoria, Calle 26, G. Yanes, 4-VIII-1994, CESUES 1680. La Colorada municipality, Km 31 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 11-IX-1996, CESUES 2791. Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 24-XI-1995, CESUES 2235. Soyopa municipality, Km 162.5 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 13-IX-1996, CESUES 3245. Baviácora municipality, Km 72 Mazocahui to Hermosillo road, E. Pérez-Silva, T. Herrera & M. Esqueda, 30-VIII-2001, CESUES 4851. Bacoachi municipality, Km 146 Mazocahui to Cananea road, M. Esqueda & J. Jiménez, 27-III-1993, AH 31759 ex CESUES 1250.

REMARKS: *Tulostoma beccarianum* is recognized by its exoperidium being thinly membranous to indistinct, tubular stoma, and spores having middle-sized verrucae under SEM. This species is frequently misidentified as was underlined by Moreno & Altés (1992) in their study of Spanish collections. This taxon has been cited in several countries, but in Mexico it was only known from Morelos, San Luis Potosí and Distrito Federal (Wright 1987). Thus, this is the first record from Sonora where it was more frequently observed in summer in microphyllous desert scrub and tropical thorn forest.

Tulostoma chudaei Pat., *Bull. Trimestriel Soc. Mycol. France* 23: 84. 1907.

(Fig. 3)

Material studied: Carbó municipality, La Granada ranch, J. Jiménez, 18-I-1994, AH 31749 ex CESUES 1601a. Hermosillo municipality, near to Puerto Libertad town, M. Esqueda, M. Coronado, A. Armenta, A. Núñez & A. Sánchez, 7-XI-1997, CESUES 3757. La Colorada municipality, Km 31 Hermosillo to Yécora road, M. Esqueda, A.

Armenta, A. Núñez & R. Santos, 17-III-1996, CESUES 2628. Ibidem, 11-IX-1996, CESUES 2793. Km 40 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 11-IX-1996, CESUES 2826. Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta A. Núñez & R. Santos, 24-XI-1995, CESUES 2232. Ibidem, 29-IV-1996, CESUES 2701. Ibidem, 26-I-1999, CESUES 4787. San Javier municipality, Km 137.5 Hermosillo to Yécora road, M. Esqueda, A. Armenta A. Núñez & R. Santos, 18-II-1996, CESUES 2505.

REMARKS: *Tulostoma chudaei* is recognized by the presence of a typical sand case at the base of the spore sac, stoma circular slightly projecting, exoperidium hyphal, spores verrucose under SEM, and stem being easily separated from the socket. This species has been cited from Africa, America and Australasia (Wright 1987). It was known only from Baja California in Mexico (Guzmán et al. 1992; Moreno et al. 1995). This taxon was present throughout the year in microphyllous desert scrub, tropical thorn forest and tropical deciduous forest.

Tulostoma cretaceum Long, *Mycologia* 36: 321-322. 1944.

(Fig. 4)

Material studied: Baviácora municipality, Km 72 Mazocahui to Hermosillo road, E. Pérez-Silva, T. Herrera & M. Esqueda, 30-VIII-2001, CESUES 4850. Hermosillo municipality, Km 125 Hermosillo to Puerto Libertad road, M. Esqueda, A. Armenta, A. Núñez & A. Sánchez, 29-VIII-1998, AH 31750 ex CESUES 4391. Puerto Peñasco municipality, Pinacate and Grand Desert Biosphere Reserve, Ejido El Norteño, J. Miranda, M. Coronado, A. Sánchez & M. Esqueda, 28-IV-2004, CESUES 5182.

REMARKS: *Tulostoma cretaceum* is recognized by its conspicuous basal mycelial cord, exoperidium hyphal, stoma fibrillose which becomes indefinite, smooth spores under SEM, and capillitium with short branches and sparse septa. It is related to the *T. obesum* group, but is usually more slender than the other species and with a ferruginous gleba (not chocolate brown coloured). There are registered collections from southwestern USA and Argentina (Wright 1987). This taxon is little known in Mexico, being cited only from Baja California (Moreno et al. 1995). In Sonora, it was observed solitary, on sandy soil in microphyllous desert scrub.

Tulostoma cyclophorum Lloyd, *The Tylostomeae* p. 25, 1906.

(Fig. 5)

Material studied: Hermosillo municipality, Centro Ecológico de Sonora, J.M. Villegas, 7-V-1993, AH 31751 ex CESUES 1584.

REMARKS: *Tulostoma cyclophorum* is distinguished by the combination of its remarkable membranous exoperidium, fibrillose stoma, small spores (3.5-4.5 μm diam.), subreticulate under SEM, and the presence of “mycosclereids” covering the

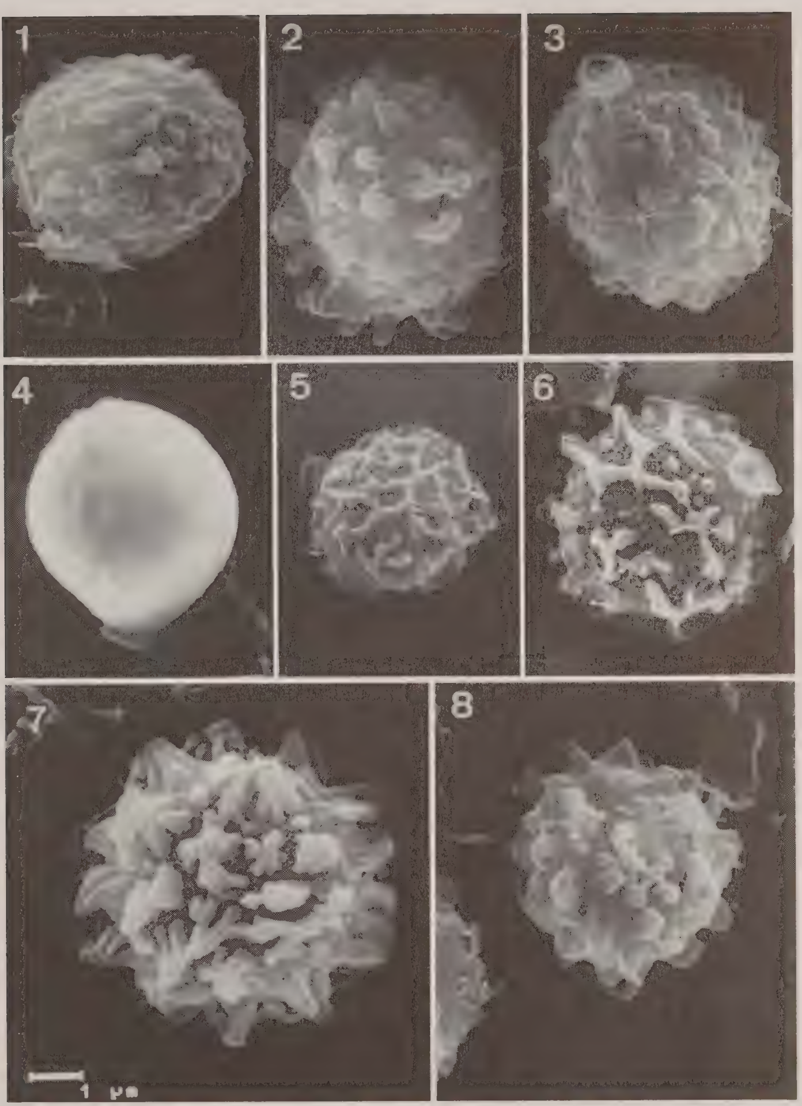

Fig. 1. *Tulostoma albicans* AH 31747. Fig. 2. *T. beccarianum* AH 31748. Fig. 3. *T. chudaei* AH 31749. Fig. 4. *T. cretaceum* AH 31750. Fig. 5. *T. cyclophorum* AH 31751. Fig. 6. *T. fimbriatum* AH 31753. Fig. 7. *T. floridanum* AH 31755. Fig. 8. *T. involucratum* AH 31756.

endoperidium. These structures were not certainly observed in our collections, probably because our specimens are overmature and weathered. However, the remaining features fit very well, and we do not know another described species with spores like these. Although this taxon has been infrequently collected, it is known from several American countries: USA, Brazil, Paraguay, Argentina and Uruguay (Wright 1987), and Europe: Spain (Moreno et al. 1990). This is the first record from Mexico, where it was found on sandy soil in microphyllous desert scrub.

Tulostoma fimbriatum Fr., *Systema Mycologicum* 3: 43. 1829.

(Fig. 6)

Material studied: Álamos municipality, Sierra de Álamos, Las Uvalamas ranch, M. Esqueda, E. Pérez-Silva, I. Buendía & V. Araujo, 12-IX-1994, CESUES 1779 (duplo in AH 31752). Bacoachi municipality, Km 146 Mazocahui to Cananea road, M. Esqueda & J. Jiménez, 27-III-1993, CESUES 1243 (duplo in AH 31753). Ibidem, M. Esqueda, 1-IV-1995, CESUES 1687. La Colorada municipality, Km 40 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 11-IX-1996, CESUES 2821. Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 16-II-1996, CESUES 2370. Ibidem, 17-III-1996, CESUES 2618. Ibidem, 29-IV-1996, CESUES 2700. Ibidem, 26-VIII-1998, CESUES 4366. Soyopa municipality, Km 162.5 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 25-VIII-1998, CESUES 4324. Yécora municipality, Km 258 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 26-XI-1995, CESUES 2312 (duplo in AH 31754). Ibidem, Km 3.2 Yécora to Sahuaripa road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 12-IX-1996, CESUES 3246. Puerto Peñasco municipality, Pinacate and Gran Desert Biosphere Reserve, Ojo de Agua, near to Sonoyta river, A. Sánchez, J. Miranda & I. Encinas, 6-XI-2003, CESUES 5049.

REMARKS: *Tulostoma fimbriatum* is recognized by its fimbriate stoma, hyphal exoperidium and spores with verrucose and subreticulate ornamentation. Within the genus *Tulostoma*, this is one of the most widely distributed species worldwide. In Sonora, it was commonly found in several types of vegetation: Microphyllous desert scrub, tropical thorn forest, tropical deciduous forest, oak woodland and *Quercus-Juniperus-Pinus* forest; solitary or gregarious, throughout the year.

Tulostoma floridanum Lloyd, *The Tylostomeae* p.18, 1906.

(Fig. 7)

Material studied: San Javier Municipality, Km 137 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez, A. Sánchez & R. Santos, 22-I-1998, CESUES 3643 (duplo in AH 31755).

REMARKS: *Tulostoma floridanum* has slender basidiocarps, exoperidium hyphal to indistinct, dark reddish brown stem, stoma tubular and spores notably echinulate (LM); under SEM, show large and conical spines which are usually fused at the apex. This species is very similar to *T. squamosum* J.F.Gmel.: Pers. in most of its features, especially by its spore ornamentation under SEM. But *T. squamosum* has a membranous to verrucose exoperidium, leaving circular and whitish plates when it falls off. These plates are formed by hyphae and sphaerocysts (Moreno et al. 1992). The sphaerocysts are absent in the hyphal exoperidium of *T. floridanum*.

Its distribution is known with certainty from USA (Florida) and Cuba and doubtfully from Australia and Arizona (Wright 1987). We found this species near the last locality (Arizona), but on soil rich in organic matter in tropical deciduous forest. This is the first record from Mexico.

Tulostoma involucratum Long, *Mycologia* 36: 330. 1944.

(Fig. 8)

Material studied: La Colorada municipality, Fuente Clara ranch, A. Aparicio, 29-VI-1993, AH 31756 ex CESUES 1684. Km 31 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 11-IX-1996, CESUES 2802. Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 24-XI-1995, CESUES 2226. Ibidem, 16-II-1996, CESUES 2362. Soyopa municipality, Km 162 Hermosillo to Yécora road, E. Pérez-Silva, T. Herrera, A. Armenta, A. Núñez & R. Santos, 13-IX-1996, CESUES 2917.

REMARKS: *Tulostoma involucratum* is characterized by its membranous exoperidium, large tubular mouth and echinulate spores under LM and large compound verrucae under SEM. In the studied collections the spore ornamentation was less well developed than in the holotype. This species has been cited from USA, Argentina and South Africa (Long 1944; Wright 1987), where it grows on sandy soil in arid regions. This is the first record from Mexico (Sonora), where it was more frequently collected in the summer showing a gregarious habit, on sandy soils, throughout the year except spring, in microphyllous desert scrub and tropical thorn forest.

Tulostoma leiosporum R.E. Fr., *Ark. Bot.* 8: 28. 1909.

(Fig. 11)

= *T. operculatum* Long & S. Ahmad, *Farlowia* 3: 256. 1947.
= *T. puncticulosum* Long & S. Ahmad, *Farlowia* 3: 246. 1947.
= *T. exitum* *sensu* J.E.Wright, *The genus Tulostoma (Gasteromycetes). A world monograph*. 1987; *sensu* Moreno et al., *Mycologia* 87: 107. 1995; *non* Long & S.Ahmad, *Farlowia* 3: 254. 1947.

Material studied: Carbó municipality, La Granada ranch, J. Jiménez, 18-I-1994, CESUES 1601b. Hermosillo municipality, Centro Ecológico de Sonora, A. Aparicio, 8-VIII-1992, AH 31757 ex CESUES 1685. La Colorada municipality, Km 31 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 16-II-1996, CESUES 2353. Ibidem, 11-IX-1996, CESUES 2811 (duplo in MEXU 24542). Km 40 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 11-IX-1996, CESUES 2816 (duplo in MEXU 24543). Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 16-II-1996, CESUES 2371. Ibidem, 9-VI-1996, CESUES 2708. Ibidem, 11-IX-1996, CESUES 2836. Ibidem, 26-I-1999, CESUES 4790. Puerto Peñasco municipality, Pinacate and Grand Desert Biosphere Reserve, Km 75 Sonoyta to San Luis Río Colorado road, J. Miranda, M. Coronado, A. Sánchez & M. Esqueda, 26-IV-2004, CESUES 5145. Ibidem, Cerro Lava, M. Esqueda, M. Coronado, A. Sánchez, J. Miranda & I. Encinas, 26-IV-2004, CESUES 5247. Ibidem, Ejido El Norteño, 28-IV-2004, CESUES 5185. San Javier municipality, Km 137 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 18-II-1996, CESUES 2504. Soyopa municipality, Km 162.5 Hermosillo to Yécora road, M. Esqueda, A.

Armenta, A. Núñez & R. Santos, 13-IX-1996, CESUES 2910. Ibidem, 22-I-1998, CESUES 3700. Ibidem, 25-VIII-1998, CESUES 4330.

REMARKS: *Tulostoma leiosporum* is characterized by its fibrillose-fimbriate to indefinite stoma, granulose exoperidium, sometimes being slightly membranous, and spores appearing smooth under LM and subsmooth (rugose) under SEM. *Tulostoma leiosporum, T. operculatum* and *T. puncticulosum* were synonymized by Moreno et al. (1997). It was previously cited in the Mexican mycobiota under the name *T. exitum* from Baja California (Moreno et al. 1995). This is the first record from Sonora, where it was most commonly collected in summer and winter in microphyllous desert scrub and tropical thorn forest.

Tulostoma macrosporum G.Cunn., *Proc. Linn. Soc. New South Walles* 50: 252. 1925.

(Fig. 9)

Material studied: Hermosillo municipality, Costa de Hermosillo, Calle 36N, G. Yanes, 5-II-1994, CESUES 1599. La Colorada municipality, Km 31 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 14-X-1995, CESUES 2169. Ibidem, 29-IV-1996, CESUES 2706. Ibidem, 11-IX-1996, CESUES 2790. Ibidem, 2-VII-1997, CESUES 3307. Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 11-IX-1996, CESUES 2833. Soyopa municipality, Km 162.5 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez, A. Sánchez & R. Santos, 22-I-1998, AH 31758 ex CESUES 3695.

REMARKS: *Tulostoma macrosporum* is recognized by its shortly tubular mouth, thinly membranous exoperidium, and mainly because of its spore size (8-12 μm diam). The most of collections collected in Sonora has a spore ornamentation seemly not very well developed, consisting in irregular membranous crests and some verrucae. Perhaps, this was caused by the maturing conditions.

It is known only in America from USA (California) (doubtful following Wright 1987) and Mexico (Baja California) (Guzmán et al. 1992). This is the first record from Sonora, where it was found on sandy soils in microphyllous desert scrub and tropical thorn forest. According to Altés & Moreno (1999), the other species of *Tulostoma* with large spores (*T. meridionale* J.E.Wright = *T. utahense* J.E.Wright) can be maintained as an autonomous taxon. *Tulostoma meridionale* shows smaller spores (6.5-9 μm diam.) with a more pronounced ornamentation. This species is also included in the Mexican catalogue of *Tulostoma* (Wright 1987; Moreno et al. 1995).

Tulostoma melanocyclum Bres. *in* Petri, *Ann. Mycol.* 2: 415. 1904.

(Fig. 10)

Material studied: Cananea municipality, Sierra de Cananea, M. Esqueda, 1-IV-1995, CESUES 1688. Yécora municipality, Km 4.8 Yécora to Sahuaripa way, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 12-IX-1996, CESUES 3244 (duplo in AH 31760).

REMARKS: *Tulostoma melanocyclum* is mainly recognized by the similar macroscopical features with *T. brumale* Pers.: Pers., but with a hyphal exoperidium

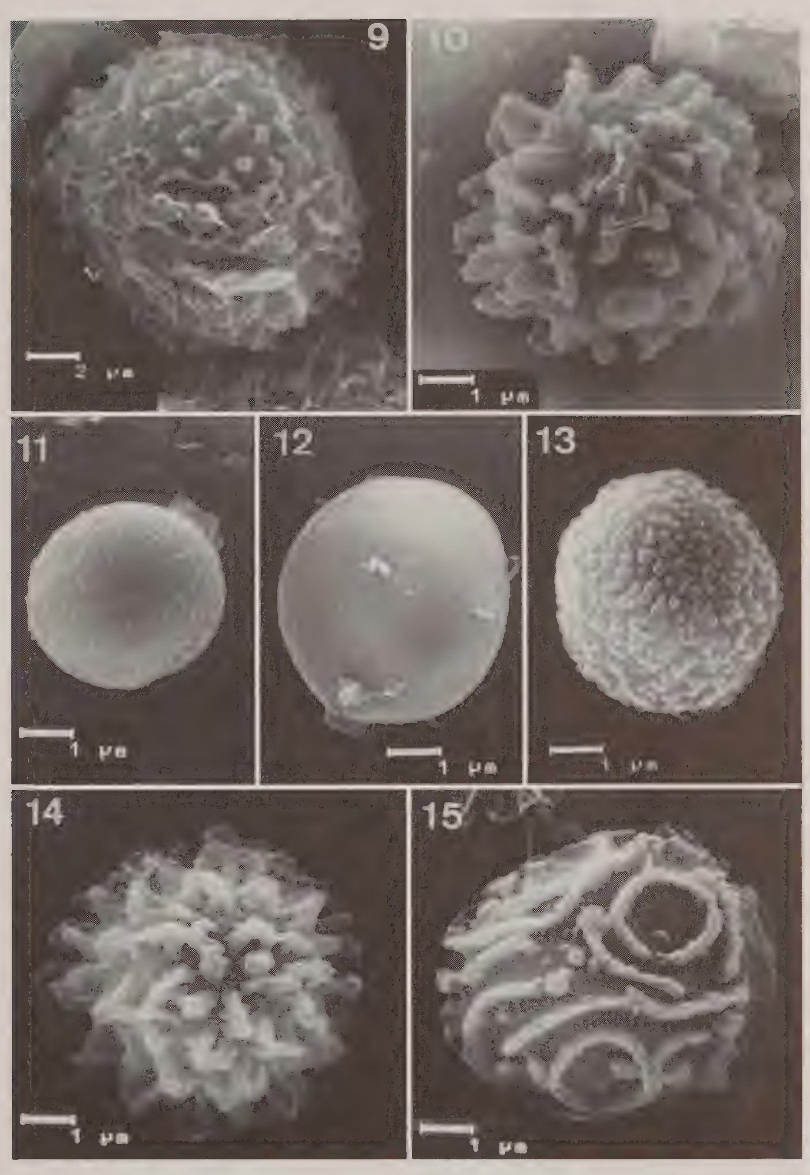
9
2 μm
10
1 μm
11
1 μm
12
1 μm
13
1 μm
14
1 μm
15
1 μm

Fig. 9. *Tulostoma macrosporum* AH 31758. Fig. 10. *T. melanocyclum* CESUES 1688. Fig. 11. *T. leiosporum* AH 31757. Fig. 12. *T. obesum* AH 31762. Fig. 13. *T. pulchellum* AH 31763. Fig. 14. *T. squamosum* AH 31765. Fig. 15. *T. striatum* AH 31764.

and different microscopic characteristics: capillitium scarcely swollen at the uncoloured septa, and spores echinulate under LM and with large spines fused at the apex under SEM (similar to the spore ornamentation of *T. squamosum*). This species is little known in the Mexican mycobiota, being previously cited only from San Luis Potosí and Estado de México (Guzmán & Herrera 1969; Wright 1987). This is the first record from Sonora, found mainly in temperate zones.

Tulostoma obesum Cooke & Ellis, *Grevillea* 6: 82, pl. 100, fig. 24. 1878.
(Fig. 12)

≡ *T. volvulatum var. obesum* (Cooke & Ellis) J.E.Wright, *The genus Tulostoma (Gasteromycetes). A world monograph.* p.212. 1987.

= *T. kansense* Peck *in* V.S.White, *Bull. Torrey Bot. Club* 28: 430. 1901.

= *T. volvulatum* var. *elatum* Har. & Pat., *Bull. Trimestriel Soc. Mycol. France* 26: 207. 1910.

= *T. volvulatum sensu* Hollós, *Die Gasteromycetes Ungarns.* 1904; *non* I.G.Borshch., *Materialy dla botanicheskoy geografii Aralo-Kaspiyskogo kraya. In Zapisky Imperatorskoy Akademii Nauk*, Suppl. vol. 7, p.189. 1865.

Material studied: Hermosillo municipality, Costa de Hermosillo, La Granada ranch, G. Yanes & J. Jiménez, 3-VIII-1994, CESUES 1612. Ibidem, Ejido 15 de Mayo, A. Sánchez, A. Armenta & M. Coronado, 15-VIII-1998, CESUES 4410. San Luis Río Colorado municipality, San Luis Río Colorado city, E. Santamaría, 19-V-1992, AH 31762 ex CESUES 910.

REMARKS: *Tulostoma obesum* is recognized by its mouth at first being more or less circular, rapidly becoming indefinite, membranous exoperidium, brown gleba, spores appearing smooth both under LM and SEM, and coloured capillitium with few and short branches, without a complete septa (Altés et al. 1999). This species has been cited in Mexico only from Baja California (Ochoa & Moreno 1996).

Tulostoma pulchellum Sacc., *Bull. Soc. Mycol. France* 5: 118. 1889.
(Fig. 13)

Material studied: La Colorada municipality, Km 31 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 11-IX-1996, AH 31763 ex CESUES 2796. Km 40 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 11-IX-1996, CESUES 2828.

REMARKS: *Tulostoma pulchellum* is recognized by its clearly membranous exoperidium, fimbriate and scutellate stoma, spores appearing almost smooth under LM, and with small and densely crowded verrucae under SEM. Its American distribution includes USA, Mexico and Argentina (Ayala et al. 1985; Wright 1987; Guzmán et al. 1992; Moreno et al. 1995). Although Guzmán & Herrera (1969) mentioned that *T. pulchellum* was known from Sonora, they established neither locality nor collection.

Tulostoma squamosum J.F. Gmel.: Pers., *Synopsis Fungorum* p.139. 1801.

(Fig. 15)

= *T. verrucosum* Morgan, *J. Cincinnati Soc. Nat. Hist.* 12: 164. 1890.
= *T. mussooriense* Henn., *Hedwigia* 40: 337. 1901.

Material studied: Álamos municipality, 7.3 km Álamos to Cuchujaqui river, A. Armenta, A. Núñez, A. Sánchez & R. Santos, 13-VI-1998, CESUES 4124 (duplo in AH 31765). San Javier municipality, Km 137 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez, A. Sánchez & R. Santos, 22-I-1998, CESUES 3651 (duplo in AH 31766).

REMARKS: *Tulostoma squamosum* is characterized by its thinly membranous exoperidium, sometimes verrucose, stoma tubular, scaly dark brown stem, exoperidium formed by hyphae and groups of sphaerocysts, and echinulate spores, which under SEM is seen to be formed by spines which are usually fused at the apex, sometimes subreticulate (Moreno et al. 1992). Our collections have stems with fewer scales than are typical for this species but the remaining features fit well. Although this taxon has been infrequently collected, it is distributed worldwide. This is the first record from Mexico. In Sonora, it was found on soil rich in organic matter in tropical deciduous forest.

Tulostoma striatum G.Cunn,, *Proc. Linn. Soc. New South Wales* 50: 255. 1925.

(Fig. 14)

Material studied: Hermosillo municipality, Centro Ecológico de Sonora, J.M. Villegas, 21-X-1993, CESUES 1586. Ibidem, Las Dunas, near to Puerto Libertad town, A. Sánchez, A. Armenta & M. Esqueda, 23-I-1998, CESUES 3748. La Colorada municipality, Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 16-II-1996, CESUES 2361 (duplo in AH 31764).

REMARKS: This species is distinguished by the usually robust spore sac, a rather short stem, a clearly membranous exoperidium, fibrillose-fimbriate stoma, and spores with striate ornamentation and small verrucae among the crests. It is interesting to point out that in the basidiocarps collected in Sonora, the spore ornamentation is striate but unusually verrucose as well. This character is intermediate between typical *T. striatum* and *T. pulchellum var. subfuscum* (V.S.White) J.E.Wright, G.Moreno & Altés.

The presence of *T. striatum* is known in several continents (Wright 1987; Altés & Moreno 1991). In Mexico, this species has been previously cited from Sonora (Wright et al. 1972; Esqueda et al. 1995). The material studied was found in autumn and winter in microphyllous desert scrub and tropical thorn forest.

Tulostoma submembranaceum G.Moreno, Ochoa & J.E.Wright, *Mycologia* 87: 117-119. 1995.

(Fig. 16)

= *T. exitum* Long & S.Ahmad, *Farlowia* 3: 254. 1947. (*nomen rejiciendum*)

Material studied: Hermosillo municipality, Las Palomas ranch, A. Aparicio, 15-II-1992, AH 31767 ex CESUES 1682. San Javier municipality, Km 137 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez, A. Sánchez & R. Santos, 22-I-1998, CESUES 3642.

REMARKS: *Tulostoma submembranaceum* is recognized by its small basidiocarps, fibrillose-fimbriate to indefinite stoma, the very thinly membranous (submembranous) nature of the exoperidium at the base of the spore sac, and minutely verrucose spores. It was described as new species with Mexican material (Baja California) by Moreno et al. (1995). This is the first record from Sonora, where was collected on sandy soil in winter in microphyllous desert scrub and tropical deciduous forest. After *T. submembranaceum* and *T. exitum* had been synonymized, the area of distribution of this species included Argentina and Pakistan (Moreno et al. 1997).

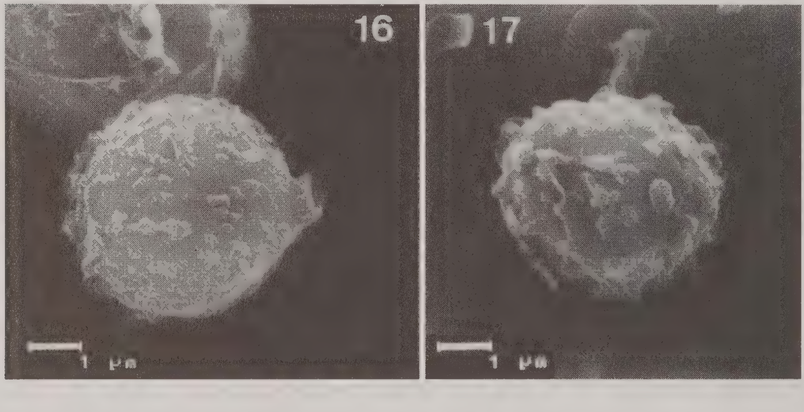

Fig. 16. *Tulostoma submembranaceum* AH 31767. Fig. 17. *T. xerophilum* AH 31768.

Tulostoma xerophilum Long, *Mycologia* 38: 85-87. 1946.

(Fig. 17)

Material studied: Álamos municipality, 7.3 km Álamos to Cuchujaqui river way, A. Sánchez, M. Coronado, A. Armenta, 15-II-1998 CESUES 3903. Baviácora municipality, Mazocahui, M. Esqueda & J. Jiménez, 26-III-1993, CESUES 1213a. La Colorada municipality, Km 31 Hermosillo to Yécora, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 17-III-1996, CESUES 2626. Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 16-II-1996, CESUES 2369. Ibidem, 17-III-1996, CESUES 2619. Ibidem, 26-VIII-1998, CESUES 4367. Ibidem, 26-I-1999, CESUES 4788. Pitiquito municipality, La Inmaculada ranch, M. Esqueda & M. Amaya, 15-II-1992, CESUES 906 (duplo in AH 31768). San Javier municipality, Km 137.5 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 26-VIII-1998, CESUES 4287. Km 151 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 22-I-1998, CESUES 3690. Soyopa municipality, Km 162.5 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 19-IV-1996, CESUES 2644. Ibidem, 22-I-1998, CESUES 3697.

REMARKS: *Tulostoma xerophilum* is characterized by its typically membranous exoperidium, tubular mouth and spores appearing asperulate under LM and with scattered scant verrucae under SEM. It was commented on above, under *T. albicans*, whereby features of *T. xerophilum* are insufficient to establish a clear difference between the two species. For the moment, we are maintaining our collections under the name *T. xerophilum,* because of its slightly slender basidiocarps and spores being somewhat smaller than *T. albicans*. This taxon is known from North America: USA (Arizona, California and Texas), Mexico (Sonora) (Long 1946; Wright 1987), and Spain (Calonge & Martín 1992). This is the second record from Sonora, where it was mainly observed in microphyllous desert scrub during winter with a solitary habit.

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Two new species of *Phanerochaete* from Taiwan

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Abstract—*Phanerochaete brunneocystidiata* and *P. lamprocystidiata*, both of which have lamprocystidia, are reported as new species from tropical and subtropical Taiwan. Descriptions, line drawings, and cultural studies are provided for both species.

Key words—*Aphyllophorales,* Basidiomycota, taxonomy, wood-decaying fungi

Introduction

The genus *Phanerochaete* P. Karst. is a member of the resupinate homo-basidiomycetes, representing the largest genus of the corticioid fungi, with about one hundred species known from around the world (Burdsall 1985, Parmasto 1997, Hjortstam 1997). Taiwan possesses an extremely high number of *Phanerochaete*, with 38 reported from the island (Lin & Chen 1990; Wu 1990, 1995, 1997, 1998, 2000, 2003; Maekawa 1992). This study adds a further two new species of *Phanerochaete* to the Taiwanese total.

Materials and Methods

Free-hand thin sections of basidiocarps were prepared for microscopic studies. For observations and measurements of microscopic characters, 5% KOH was used as a mounting medium to ensure rehydration. Melzer's reagent (IKI) was employed to detect amyloidity and dextrinoidity. Cotton blue (CB) was used as a mounting medium to determine cyanophily. Cultural descriptions and species code diagnoses are from Nobles (1965) with amendments by Boidin and Lanquetin (1983, 1984). Nobles' code as detailed by Nakasone (1990) is adopted in this study. General methods of cultural studies have been previously described by Wu (1996). All studied specimens, as well as fungal cultures, are deposited at the herbarium of the National Museum of Natural Science of ROC (TNM). Isotypes of the two new species are to be distributed to K.

Taxonomy

Phanerochaete brunneocystidiata Sheng H. Wu, sp. nov. (Figs 1-4)

Basidiocarpus effusus, submembranaceo-pelliculus, 80-200 µm crassus; superficies hymenialis plana. Systema hypharum monomiticum; hyphae efibulatae. Lamprocystidia *subulata, brunnea. Basidia clavata, 20-30 x 5.5-6 µm., 4 sterigmatibus. Basidiosporae anguste ellipsoideae, laeves, tenuitunicatae, 5.5-7.5 x 2.7-3.3 µm, IKI-, CB-.*

Etymology. From *brunneus* (= brown) + *cystidiata*, referring to the distinct cystidia in this species.

Basidiocarp resupinate, effuse, submembranaceous-pellicular, 80-200 µm thick in section. Hymenial surface pale brownish gray or clay-coloured, smooth, cracked when old; margin thinning, paler, pruinose-filamentose. Hyphal system monomitic; hyphae simple-septate. Subiculum up to ca. 150 µm thick, with fairly loose texture; hyphae variously oriented, colourless, 2.5-4 µm diam., with 0.4-0.8 µm thick walls. Hymenium can be thickening; hyphae colourless, 2-3 µm diam., thin-walled. Lamprocystidia immersed or emergent, arising from subiculum or hymenium. terminal or pleural, subulate, brownish, 25-80 x 5-8 µm (with encrustation), with 0.8-1.8 µm thick walls, those from subiculum usually with elongated, tubular basal parts. Basidia clavate, 20-30 x 5.5-6 µm, 4-sterigmate. Basidiospores narrowly ellipsoid, smooth, thin-walled, 5.5-7.5 x 2.7-3.3 µm, IKI-, CB-.

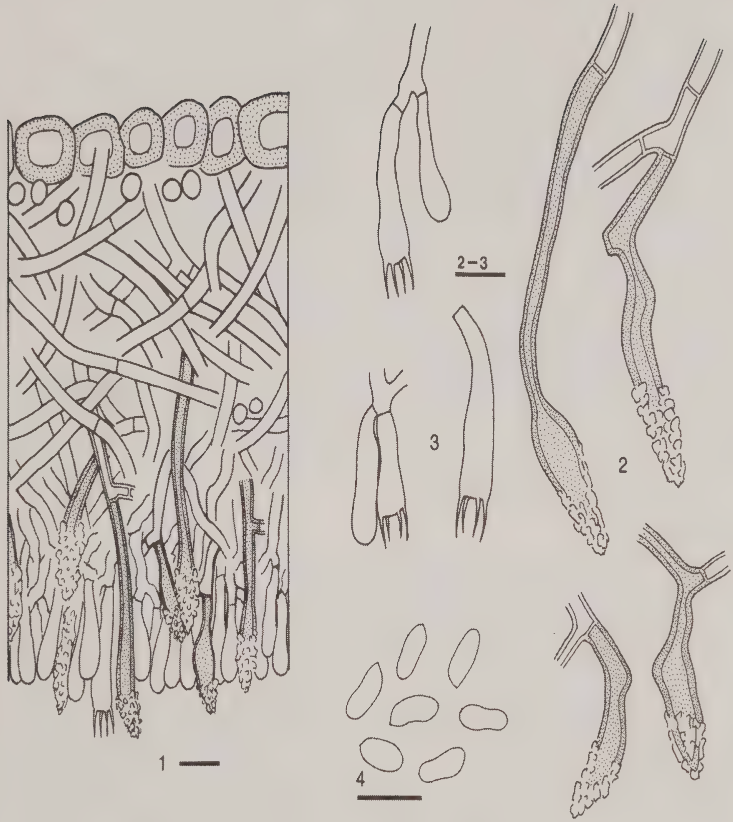
Distribution. **Taiwan.**

Holotype. Taiwan: Taitung: Lanyu, Hungtoushan, alt. 500 m, on branch of *Freycinetia formosana, leg. S.Z. Chen,* 24 Apr 1997, *Chen 666 (*TNM F8832; isotype: K).

Additional specimens examined. Taiwan: Taitung: Lanyu, Hungtoushan, alt. 350 m, on branch of *Freycinetia formosana, leg. S.Z. Chen,* 23 Apr 1997, *Chen 646* (TNM F8847). Lanyu, on the way to Tienchih, alt. 100 m, on branch of *Freycinetia formosana, leg. S.H. Wu & J.Y. Tseng, 1* May 1997, *Wu 9705-37* (TNM F8760); alt. 280 m, on branch of *Fteycinetia formosana, leg. S.H. Wu & J.Y. Tseng, Wu 9805-14* (TNM F10012), alt. 200 m, *Wu 9805-23* (TNM F10021); alt. 200 m, on branch of *Freycinetia formosana, leg. S.Z. Chen,* 24 Oct 1999, *Chen 939* (TNM F10587); alt. 300 m, on branch of *Freycinetia formosana, leg. S.Z. Chen*, 26 Aug 2002, *Chen 1165* (TNM F14782); alt. 350 m, on branch of *Freycinetia formosana, leg. S.Z. Chen,* 26 Aug 2002, *Chen 1143* (TNM F14774), 16 May 2003, *Chen 1274* (TNM F15127). Lanyu, Hsiaotienchih, alt. 150 m, on branch of *Pandanus odoratissimus, leg. S.Z. Chen,* 17 July 2000, *Chen 1078* (TNM F12031),

Cultural description (combined from polysporous mycelia of *Chen 666* and *Chen 1143*). 1 wk growth: Colony radius 52-74 mm. Mat white. Advancing zone uneven. Aerial mycelium pellicular around inoculum, downy elsewhere, plumose in the advancing zone. Advancing hyphae colourless, 2.5-8.5 µm diam., thin-walled, simple-septate. 2 wk growth: Plates covered. Mat white. Aerial mycelium pellicular. 6 wk growth: Plates covered. Mat white, no change in KOH. Aerial mycelium pellicular, occasionally slightly crustose, plumose towards the plate margin. No distinct odor. Not fruiting. Agar bleached. Hyphal system monomitic; aerial hyphae colourless, sparsely or moderately branched, 2-4 µm diam., generally thin-walled, occasionally slightly thick-walled, simple-septate, covered with oily secretion; submerged hyphae colourless, sparsely or moderately branched, 2.5-8 µm diam., mostly thin-walled, rarely slightly thick-walled, simple-septate, rarely with single, double, or multiple clamp connections. Crystals present.

Oxidase reactions. TAA: – or +, tr; – or +, tr. GAA: ++ to ++++, 13-53; ++ to ++++, 20-90+. TyA: –, 55-75; –, 90+.



Figs 1-4. *Phanerochaete brunneocystidiata* (holotype). Fig. 1. Section through basidiocarp. Fig. 2. Lamprocystidia. Fig. 3. Basidia. Fig. 4. Basidiospores. Scale bars = 10 μm.

Species code. (2a). 5. 7. 32. 36. 40. 42. 54.

Remarks. *Phanerochaete brunneocystidiata* resembles *P. crassa* (Lév.) Burds. in having brown lamprocystidia with elongated, tubular basal parts, and having similar-sized basidiospores. *Phanerochaete crassa* grows on hardwood, having resupinate basidiocarps with reflexed margin. *Phanerochaete brunneocystidiata* differs from *P. crassa* by growing on *Pandanaceae* (so far known from *Freycinetia* and *Pandanus*), having absolutely resupinate basidiocarps, and bearing shorter cystidia. This new species is known only from Lanyu (also known as Orchid Island or Botel Tobago), a 46 km^2 tropical island located to the south-east of the main island of Taiwan.

Phanerochaete lamprocystidiata Sheng H. Wu, sp. nov. (Figs 6-10)

Basidiocarpus effusus, ceraceus, 80-280 µm crassus; superficies hymenialis plana. Systema hypharum monomiticum; hyphae efibulatae. Lamprocystidia subulata. Basidia anguste clavata, 30-50 x 5.3-6.3 µm, 4 sterigmatibus. Basidiosporae late ellipsoideae, laeves, tenuitunicatae, (5-) 5.5-7.5 (-8) x 3.8-4.8 µm, IKI-, CB-.

Etymology. Lamprocystidiata, referring to the presence of lamprocystidia in the species.

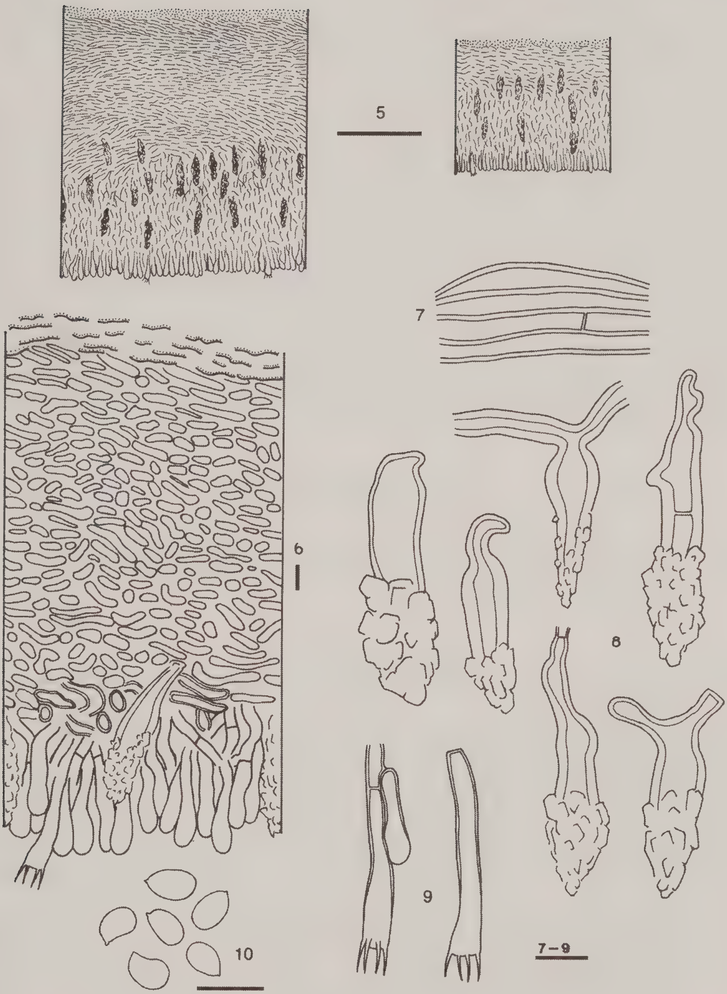
Basidiocarp resupinate, at first forming orbicular patches, then becoming effuse, ceraceous, corneous when dried, 80-280 µm thick in section. Hymenial surface white, grayish white, yellowish white or grayish yellow, smooth, cracked when old; margin fairly determinate, concolorous, usually separable or rolled off from substratum when old. Hyphal system monomitic; hyphae simple-septate. Subiculum with compact texture, composed of a thick and distinct basal layer, up to ca. 150 µm thick; hyphae horizontal, colourless, glued together and almost inseparable, 3-5 µm diam., with 0.5-1µm thick walls. Hymenium occasionally thickening; hyphae colourless, 2-4 µm diam., thin-walled. Lamprocystidia mostly immersed, arising from basal layer close to hymenium, or from hymenial layer, terminal or pleural, subulate, colourless, 30-70 x 10-18 µm (with encrustation), with 1-3 µm thick walls. Basidia narrowly clavate, 30-50 x 5.3-6.3 µm, 4-sterigmate. Basidiospores broadly ellipsoid, smooth, thin-walled, (5-) 5.5-7.5 (-8) x 3.8-4.8 µm, IKI-, CB-.

Distribution. Taiwan.

Holotype. Taiwan. Miaoli: Tahu, Shuiliutung, alt. 250 m, on branch of angiosperm, *leg. S.Z. Chen*, 13 Nov 2000, *Chen 1018* (TNM F12069; isotype: K).

Additional specimens examined. Taiwan. Taipei: Yangminshan, alt. 400 m, on branch of angiosperm, *leg. S.H. Wu*, 24 Jul 1991, *Wu 910724-10* (TNM F252), *910724-14* (TNM F51), *910724-16* (TNM F52), *910724-21* (TNM F253), *910724-24* (TNM F254), *910724-30* (TNM F255) (on branch of *Prunus campanulata*); Kungliao, alt. 200 m, on branch of angiosperm, 25 Jul 1991, *Wu 910725-8* (TNM F258). National Taiwan University, on branch of *Melaleuca leucadendron*, *leg. S.H. Wu*, 17 Oct 1999, *Wu 9910-1* (TNM F10439); on branch of *Koelreuteria henryi*, *leg. S.H. Wu*, 23 Dec 2001, *Wu 0112-41* (TNM F13842). Ilan: Fushan Nature Reserve, alt. 600 m, on branch of angiosperm, *leg. S.H. Wu*, 7 Aug 1991, *Wu 910807-33* (TNM F134). Taichung: Takeng, on branch of angiosperm, *leg. S.Z. Chen*, 7 Nov 1993, *Wu 9311-2* (TNM F1409); Tunghai University, alt. 150 m, on branch of angiosperm, *leg. R.L. Wang & Y.W. Pan*, 21 Aug 1994, *Wu 9408-37* (TNM F2466). Nantou: Lienhuachih, alt. 700 m, on branch of angiosperm, *leg. S.H. Wu*, 25 Oct 1988, *Wu 881025-41* (TNM F14927); *leg. S.Z. Chen*, 19 Oct 1995, *Chen 369* (TNM F4239). Pingtung: Chufengshan, alt. 300 m, on branch of angiosperm, *leg. S.Z. Chen*, 24 May 1998, *Chen 811* (TNM F9889). Hualien: Tailuko, Shenmiku Hiking Trail, on branch of angiosperm, *leg. S.H. Wu et al.*, 10 Sep 2001, *Wu 0109-14* (TNM F13759).

Cultural description (combined from polysporous mycelia of *Chen 1018* and *Wu 881025-41*). 1 wk growth: Colony radius 46-58 mm. Mat white. Advancing zone even. Aerial mycelium downy to cottony. Advancing hyphae colourless, 2.5-6.5 µm diam., thin-walled, simple-septate. 2 wk growth: Plates covered. Mat white. Aerial mycelium pellicular around inoculum, downy to cottony elsewhere. 6 wk growth: Mat white, not change in KOH. Aerial mycelium slightly pellicular. No distinct odor. Not fruiting.



Figs 5-10. *Phanerochaete lamprocystidiata* (Fig. 5: *Wu 9408-37*, Figs. 6-10: holotype). Figs. 5-6. Section through basidiocarp. Fig. 7. Basal hyphae. Fig. 8. Lamprocystidia. Fig. 9. Basidia. Fig. 10. Basidiospores.

Scale bars = 100 μm for Fig. 5; = 10 μm for Figs. 6-10.

Agar bleached. Hyphal system monomitic; hyphae colourless, moderately branched, 2-6.5 μm diam., thin-walled, mostly simple-septate, rarely with single, double, or multiple clamp connections. Crystals present.

Oxidase reactions. TAA: +++, 30-40; +++, 55-70. GAA: ++ or +++, 40-52; ++++. TyA: –, 53-60; –, 90+.

Species code. (2a). 5. 7. 32. 36. 40. 42. 54.

Remarks. Phanerochaete lamprocystidiata is characterized by having white to cream basidiocarps, which have a fairly tough consistency. Microscopically, it has a distinct basal layer of compact texture, and bears distinct lamprocystidia. This species is fairly common in subtropical and tropical Taiwan, growing on dead angiosperm wood. Although fairly common in Taiwan, basidiocarps of this species were quite often found without bearing spores. Specimens without spores were not included in this study, and were also not preserved in TNM. *Phanerochaete lamprocystidiata* resembles *P. flavidoalba* (Cooke) S.S. Rattan in the dense texture of its basidiocarps, in having lamprocystidia and in its similar-sized basidiospores. *Phanerochaete lamprocystidiata* generally has whitish hymenial surface, while that of *P. flavidoalba* is yellow-buff. *Phanerochaete lamprocystidiata* has a distinct and thick basal layer, while that of *P. flavidoalba* is thin and sometimes indistinct.

Acknowledgements

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MYCOTAXON

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Phytophthora cyperi on *Digitaria ciliaris* in Hainan Province of China

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Abstract—*Phytophthora cyperi* was discovered in Hainan, China for the first time on *Digitaria ciliaris* (Family *Poaceae*). This is also the first world record of the fungus on a plant species other than *Cyperus*. The controversial nomenclature of the fungal species is discussed.

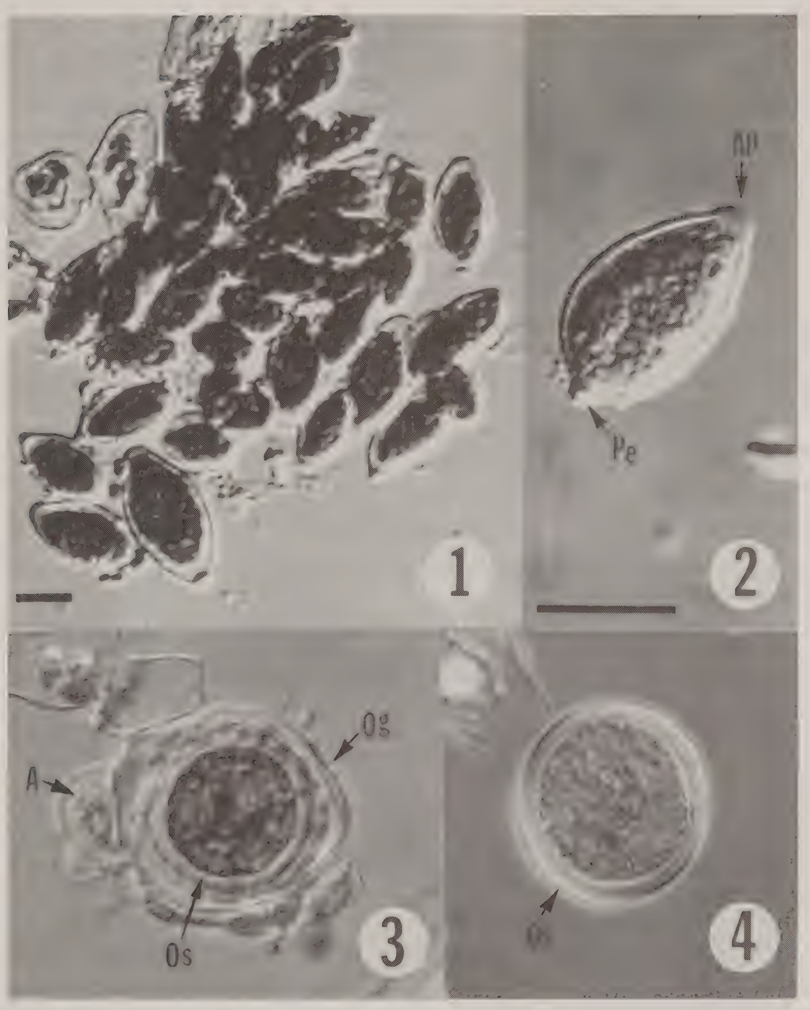
Key words—*Peronospora cyperi, Kawakamia cyperi, Cyperaceae,* oomycete

Phytophthora cyperi (Ideta) Ito is a rather uncommon species within the genus *Phytophthora* de Bary. It is parasitic only on species of *Cyperus* (Family *Cyperaceae*), causing brown spots in the stems, leaves and peduncles as well as blight, but its nomenclature is confusing. It was first reported as *Peronospora cyperi* (Ideta 1903, cited in Waterhouse 1956) as the causal agent for red disease or tortoise-shell on shichito mat grass, *C. malaccensis* Lam. in Japan. Miyabe (1903) erected the genus *Kawakamia* and named the fungus on the sedge, *C. tegetiformis* Roxb. as *K. cyperi* (Miyabe & Ideta) Miyabe, synonymous with *Peronospora(?) cyperi* Miyata & Ideta. He considered the genus "nearly allied to *Phytophthora*, from which it differs by the presence of a pedicel-cell and a peculiar tail-like appendage to its conidium, and also by the shape of the conidia and conidiophores." Later, the pathogen was also found on *C. malaccensis* and *C. tegetiformis* in various parts of Taiwan (Kawakamia and Suzuki 1908, Sawada 1915, 1919). In the United States, the fungus was found in Texas and South Carolina in test plots of *C. tegetiformis* imported from Japan (Patterson and Charles 1910) causing downy mildew (anonymous 1960). Wilson (1914) re-examined the diseased specimens from Texas and confirmed its identity. He further noted that "the conidia present a striking likeness in outline to those of *Phytophthora*, but the pedicel is more conspicuous than in any species of this last genus". Based on the drawings of Sawada (1919), Fitzpatrick (1930) concluded "there is no basis for separating it from *Phytophthora*." Ito and Tokunaga (1935) gave it the corrected name: *Phytophthora* *cyperi*. Waterhouse (1956) placed *Kawakamia* in synonym with *Phytophthora*, a view shared by most *Phytophthora* researchers (Erwin and Ribeiro 1996). On the other hand, Farr et al. (1989) noted that " the identity of this species is obscure" and recorded the pathogen on *Cyperus* in Texas as *Peronospora cyperi*. However, there is little justification to retain the name *Peronospora*. The conidia of *Peronospora* are non-poroid with uniform wall, germinating only by germ tubes whereas the sporangium of *Phytophthora* has a distinct apex the thickening of which varies with the species (Waterhouse 1973).

Sawada (1927, 1931) also described two similar species on the leaves of *C. rotundati* L. and *C. iriae* L. in Taiwan, respectively as *P. cyperi-rotundati* Sawada and *P. cyperi-iriae* Sawada based primarily on the antheridia, which are predominantly paragynous in the former and paragynous or amphigynous in the latter. Waterhouse (1963) determined that all three species are very similar and she broadened the species concept of *P. cyperi* to include *P. cyperi-rotundati* and *P. cyperi-iriae*. It is characterized by its inability to grow on artificial media, its host specificity on *Cyperus*, the production of caducous, ovoid-ellipsoidal sporangia 52 x 30 μm (L/B ratio 1.7), with flattened apex and shallow apical thickening as well as short occluded pedicel (under 4μm long), spherical smooth oogonia (42 μm diam), oospore almost filling the oogonium (wall 3 μm thick) and predominantly paragynous antheridia (20 x 10 μm). Ho and Chang (1992) re-examined Sawada's original specimens and came to the same conclusion. The "peculiar tail-like appendage of the conidia" as described by Miyabe (1903) was not found. The senior author studied Kawakami's specimen of *K. cyperi* on *C. tegiformis* (BPI 761963) available from the US National Fungus Collection and could not find the "tail-like appendage" but every caducous sporangium bears a short pedicel . It is quite possible that the "peculiar tail-like appendage of the conidia" is the same as the pedicel of the sporangia. In his original description, Miyabe (1903) stated that "cross partition between the conidium and pedicel-cell thickens conspicuously, and remains attached, to a fallen conidium forming a peculiar short tail".

In distribution, *P. cyperi* is limited primarily to Japan, Taiwan and two southern states of America although it was also found in India (Sahaya 1936, Seethalakshmi 1953) causing respectively, leaf blight of *C. tegetiformis* (reported as *K. cyperi*) and *C. rotundus* (reported as *P. cyperi rotundati*). Apparently, there has been no new record of the fungus since the early reports until Tai and Zhang (1990) found it on *C. malaccensis* var. *brevifolius* in Guanxi Province of mainland China.

In June 1998, we found a patch of *Digitaria ciliaris* (Retz) Koeler (Family *Poaceae*) with brown leaf spots and blight of the leaf tips, located in front of the plant pathology laboratory on the campus ground of the Chinese Academy of Tropical Agricultural Sciences. On close examination, we found clusters of deciduous oval semi-papillate sporangia (31x18 μm, L/B ratio 1.8), with apical thickening under 3 μm thick and occluded short pedicel, less than 5 μm long (Figs. 1, 2) produced on sporangiophores through stomata. The hyphae are non-septate, colorless, irregular and knobby growing between host cells. Sex organs (Figs. 3, 4) were found in the intercellular spaces within the leaf tissues. The smooth oogonia (42 μm diam) are brownish, smooth with spherical oospore (31μm diam), oospore wall 2 μm thick and antheridia are paragynous.



Figs. 1-4. *Phytophthora cyperi*. (1) Cluster of sporangia (2) Semi-papillate sporangium with apical thickening (Ap) and short pedicel (Pe) (3) Oogonium (Og) with oospore (Os) and antheridium (A) (4) Oospore (Os) free from oogonium. Scale bar = 10 μm (Fig.1) and 20 μm (Figs. 2-4)

The measurements of the reproductive structures compared well with those reported by Ho *et al* (1995) based on a study of Sawada's original specimens: sporangia 39 x 23 μm (L/B ratio 1.7), oogonia 37 μm diam and oospores 30 μm diam (wall 3 μm thick). Ideta's specimen of *K. cyperis* on *C. tegiformis* (BPI 761963) contains oogonia 36 μm diam and oospores 29 μm diam (wall 2–4 μm thick) whereas Kawakami's specimen

(BPI 76192) contains sporangia measuring 52 x 28 µm (L/B ratio 1.9). Attempts to grow the fungus on artificial agar media failed. Based on these characteristics, the fungus has been identified as *P. cyperi*. It could not be found anywhere else in Hainan other than this discovery. To the best of our knowledge, this is the first report of *P. cyperi* in Hainan, China and also the first record of the fungus on a member of the family *Poaceae* (*Gramineae*) in the world. To date, *P. cyperi* has been known only on species of *Cyperus* although there was a report of foliage blight of bulbous irises, which are mostly hybrids of *Iris xiphium,* and *I. tingitana* (Family *Iridaceae*) in England "associated with an unidentified *Phytophthora* which is possibly related to *P. Cyperi-rotundati* Sawada" (Gibson and Gregory 1940).

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New records of *Liceales* from China[1]

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Abstract—Six species of *Liceales—Licea pusilla, L. variabilis, Tubifera dictyoderma, Cribraria ferruginea, C. filiformis,* and *C. macrospora*—are described and illustrated. They are reported from China for the first time.

Key words—Myxomycetes, SEM, distribution

Introduction

Liceales is suitable for a phylogenetic study of Myxomycetes because of its large variation in morphological characteristics. In *Liceales,* three families, seven genera, and 112 species have been reported worldwide (Kirk et al. 2001).

The first report of Chinese *Liceales* from Taiwan cited 15 species and 4 varieties (Nakazawa 1929), but voucher specimens cannot be found in the herbaria on mainland China.

In the first report from mainland China, Skvortzow (1931) reported 5 species, 3 genera of *Liceales* from Heilongjiang Province including 2 new species, *Licea brassica* Skv. and *L. mandshurica* Skv. The holotypes deposited in the herbarium, Institute of Microbiology, Chinese Academy of Science (HMAS), were checked by Zhou and Li (1978). Martin and Alexopoulos (1969) regarded *L. mandshurica* as a doubtful species because it bears limy plates on the peridium similar to *Lepidoderma*. Zhou and Li (1978) suggested that *L. mandshurica* belongs to the *Physarales* due to its purplish brown spores and limy granules. The type specimen has been damaged and can no longer be identified. Emoto (1931, 1933) reported 3 species in 3 genera of Liceales from Liaoning Province, China. Teng, the Chinese Mycologist who first reported Myxomycetes from China, reported 3 genera, 5 species of *Liceales* from South China (Teng & Teng 1933, 1935, 1937). Later, he reported 10 genera, 16 species and showed the habits and distributions of these species from China (Teng 1963).

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Zhou (1937) reported 5 genera, 5 species of Liceales from North China, including 2 newly recorded genera and 2 newly recorded species. Later, Buchet (1939) reported 2 species of Liceales based on the specimens collected by Licent from Taiyuan, China.

Zhou and Li (1983) decribed a new species, *Cribraria enodis* Zhou & Y. Li. Later, 4 new species, *C. media* H. Li & Y. Li, *Licea reticulospora* H. Li & Y. Li, *Cribraria irregularis* Y. Li and *Cribraria paucidictyon* Y. Li, were described (Li & Li 1994, 1995; Li 2002).

Liu (1981, 1982) reported the Myxomycetes in Jilin Province, including 7 genera, 30 species; Zhou and Li (1983, 1985) reported 4 genera, 6 species in Xinjiang and Tibet; Li (1983) systematically studied *Cribraria* and reported 8 new records; Ing (1987) reported 2 genera, 8 species in Hong Kong; Li (1989) reported 7 genera, 18 species in Shennongjia; and Li and Li (1989) listed 8 genera, 42 species in China.

Later, Li and Chen (1993) and Chen et al. (1994) reported 4 genera, 8 species in Inner Mongolia, and Wang et al. (1994) reported 5 genera, 14 species in Heilongjiang, including one new record. Some species were alternatively obtained through moist chamber culture (Champion and Mitchell 1980; Zhou et al. 1981; Zhao 1983; Chen et al. 1995a). Some reports are from Taiwan (Chiang and Liu 1991; Liu 1980, 1981, 1982, 1983, 1989, 1990; Liu et al. 2002) and Hong Kong (Chung 1997).

To date, 3 families, 8 genera and 50 species in *Liceales* are now reported from China.

In this study, the specimens collected from China and deposited in Mycological Herbarium of Jilin Agricultural University (HMJAU) and the herbarium, Institute of Microbiology, Chinese Academy of Science (HMAS) were checked and re-examined. Six new records, 2 of *Licea,* 1 of *Tubifera* and 3 of *Cribraria,* are added to Chinese flora. The known distributions of these newly record species are provided.

Materials and Methods

The specimens deposited in HMJAU and HMAS were re-examined. Additional specimens, which were obtained from our own field surveys, were also examined. Observations were carried out with a stereomicroscope (40x) and Olympus optical microscope (100x–1000x) after mounting in lactophenol (phenol 20 ml, lactic acid 20 ml, distilled water 20 ml), or in distilled water. The dried specimens of entire sporocarps and broken myxocarps were attached to double-sided adhesive tape on specimen holders of a Scanning Electron Microscope (SEM), and coated with platinum-palladium using a Hitachi E-1030 I sputter. The myxocarps were examined by SEM in the University of Tsukuba, Japan using a Hitachi S-4200 instrument operating at 15 kv.

Taxonomic Descriptions

Licea pusilla Schrad., Nov. Gen. Pl. 19, 1797. FIGURE 1 (1, 2)

Myxocarp sporocarpous; sporocarps scattered or gregarious, sessile, globose, subglobose to pulvinate on a somewhat restricted base, more or less angular, blackish brown to dull black, shining, greatly variable in size, usually 0.5-1.3 mm in diameter; peridium thick, consisting of two closely appressed layers, dehiscent from above reticulate ridges into

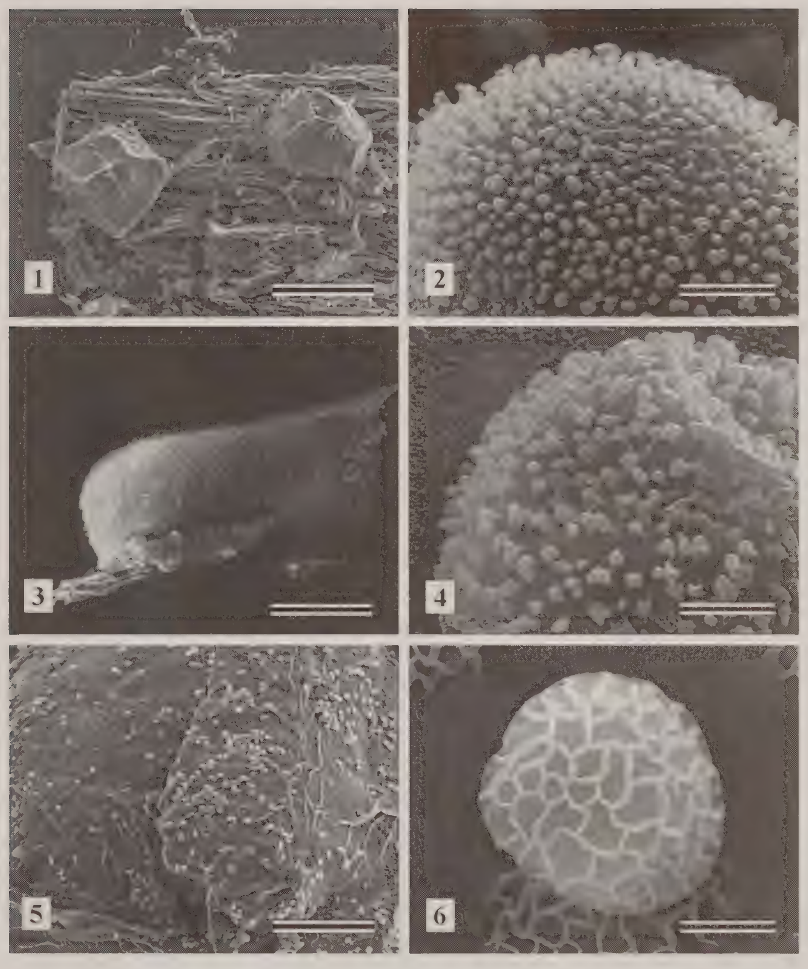

Fig. 1. 1-2. *Licea pusilla* (HMJAU 10061). 1. Two sporocarps (Bar = 200μm). 2. Spore surface (Bar = 2μm). 3-4. *Licea variabilis* (HMAS 1235). 3. Plasmodiocarp (Bar = 0.5 mm). 4. Spore surface (Bar = 2μm). 5-6. *Tubifera dictyoderma* (HMAS 68077). 5. Peridium (Bar = 100μm). 6. Spore (Bar = 2μm).

lobes; spores dark brown in mass, pale olivaceous brown by transmitted light, with wall thinner on one side, globose, densely and minutely warted by SEM, (14.3-) 15.6-16.9(-19.5) μm in diameter.

Ecology and Distribution: On rotten wood and dead bark. Known in Heilongjiang.

SPECIMEN EXAMINED: **P. R. CHINA. Heilongjiang.** Aug. 1992.*HMJAU 10061*, Wang.

Remarks: This species is the type of the genus *Licea,* and is regarded as cosmopolitan by some authors (Martin and Alexopoulos 1969; Nannenga-Bremekamp 1991), though it has not previously been reported in China. Because of its relative small size and scattered habit, it is very difficult to find this species in the field. In the species of *Licea* where the peridium has preformed reticulate dehiscence, *L. pusilla* differs from *L. erectoides* Nann.-Bremek. & Y. Yamam. in its sessile sporocarp, from *L. castanea* G. Lister in its larger spores, and from *L. minima* Fr. in its non-cartilaginous peridium and larger spores. This is the first report of this species for Chinese myxomycete biota.

Licea variabilis Schrad., Nov. Gen. Pl. 18, 1797. FIGURE 1 (3, 4)

Myxocarps plasmodiocarpous and/or sporocarpous, scattered or gregarious in small groups; plasmodiocarps elongate to annulate, 1-10 mm long and 0.3-1.0 mm wide, sometimes branching; sporocarps sessile, subglobose to pulvinate, varying in colour from fresh ochraceous to dull dark brown, 0.5-0.8 mm in diameter; peridium consisting of two layers, dehiscing irregularly; outer layer of peridium thick, with dirt particles, gelatinous when fresh; inner layer of peridium membranous, translucent, yellowish; hypothallus usually developed, dull yellow to brown; spores olivaceous to dark reddish brown in mass, pale yellowish brown by transmitted light, globose, minutely and densely spinulose by light microscope (LM), warted by SEM, (10-) 12.5-15 μm in diameter.

Ecology and Distribution: On rotten wood and dead bark. Known in Heilongjiang and Inner Mongolia.

SPECIMENS EXAMINED: **P. R. CHINA. Heilongjiang.** Aug. 1992. *HMJAU 10093,* Wang. **INNER MONGOLIA.** Aug. 1991. *HMAS 1235,* Li.

Remarks: As suggested by its specific name, this is a highly variable species. Its characteristics vary in several aspects such as the type, shape and size of myxocarp and the colour and size of its spores. It is one of the largest species in *Licea* where most species form much smaller sporocarps. It is reported to be rather common but, from China, this is the first report.

Tubifera dictyoderma Nann.-Bremek. & Loerak., Proc. K. Ned. Akad. Wet. Ser. C. 88: 121, 1985. FIGURE 1 (5, 6)

Myxocarps pseudoaethalioid, sessile, consisting of densely connected sporocarps, on a slightly protruding hypothallus, slightly depressed, with a smooth surface above, greyish brown to pale chestnut brown, more or less depressed hemispheric, about 5 cm in diameter; sporothecae cylindrical, rounded angular in cross section because of mutual compression, about 3-5 mm tall and 0.5 mm in diameter; peridium sturdy, permanent, with apical walls flattened and reticulate, with vertical walls so close together that they seem merged; pseudocapillitium not present; hypothallus slightly protruding, dull white to whitish yellow; spores cinnamon in mass, pale pink-brown by transmitted light, globose, reticulate, 4.7-5.2 μm in diameter.

Ecology and Distribution: On moss. Known in Jilin.

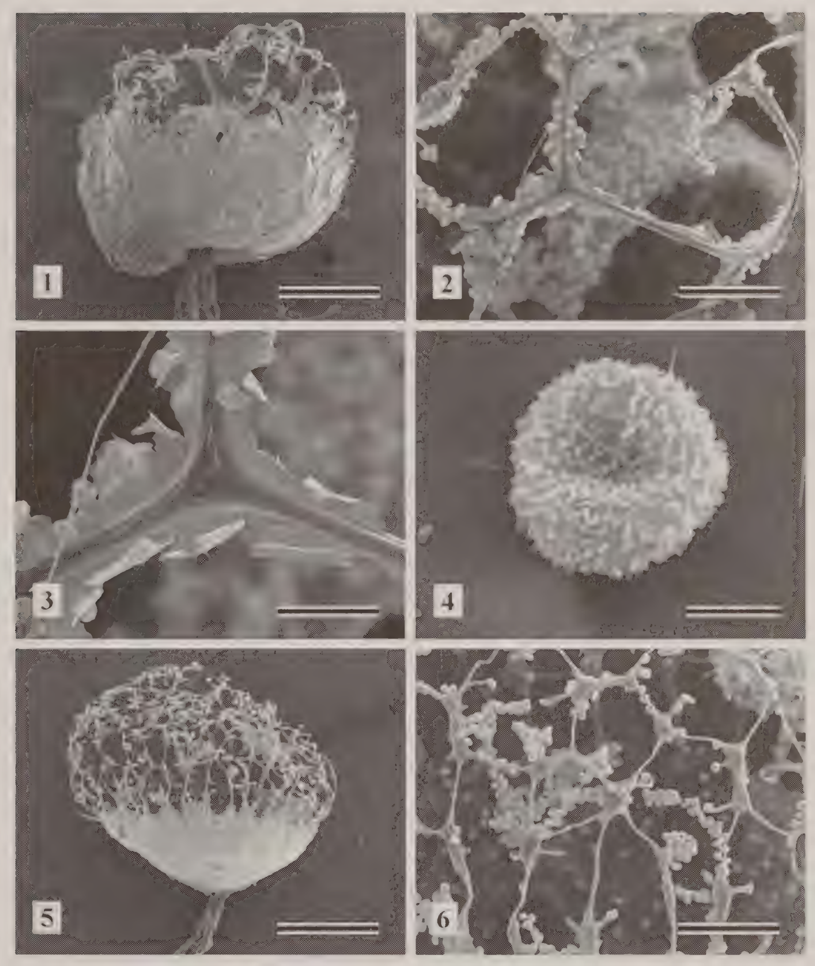

Fig. 2. 1-4. *Cribraria ferruginea* (HMJAU 9589). 1. Peridial net and cup with a stalk (Bar = 300μm). 2. Part of the peridial net (Bar = 60μm). 3. Node with threads (Bar = 20μm). 4. Spore (Bar = 2μm). 5-6. *Cribraria filiformis* (HMAS 91-392). 5. Peridial net and cup with a stalk (Bar = 200μm). 6. Part of the peridial net (Bar = 60μm).

SPECIMENS EXAMINED: **P. R. CHINA. Jilin.** Sep. 1998. *HMJAU 10064*, Chen. **Jilin.** July 1998. *HMAS 68077*, Wang.

Remarks: It is obviously an intermediate species between *Tubifera* and *Dictydiaethalium*, resembling the latter in its tessellated peridial surface and method of dehiscence of the pseudoaethalium, but other characteristics clearly group it into the genus *Tubifera*. This specimen differs from the original description (Nannenga-Bremekamp 1985) in not distinctly depressed pseudoaethalia and no capillitia.

Cribraria ferruginea Meylan, Ann. Cons. Jard. Geneve 15-16: 319, 1913.

FIGURE 2 (1-4)

Sporocarps sporocarpous; sporocarps stalked, gregarious or crowded in a group, reddish brown or rusty brown, erect, subglobose or pyriform, 1.0-1.5 mm in diameter, 2.0-3.0 mm tall; net occupying about 2/3 of the sporothecae, loose; net meshes irregular; connecting threads slender; nodes irregular and flattened; cups usually lacking, replaced by sturdy ribs which radiate from the top of stalks; ribs interconnected; dictydine granules 1.5-2.0 μm in diameter; stalk short and robust, longitudinally furrowed, equaling to about half of the diameter, dark red brown or dark fusty brown; hypothallus extending and confluent under the whole group, dark red brown; spores reddish brown in mass, pale rusty red by transmitted light, globose, minutely warted and faintly reticulated by LM, conical-warted by SEM, 6.5-7.8 μm in diameter.

Ecology and Distribution: On dead wood. Known in Jilin and Shaanxi.

SPECIMEN EXAMINED: **P. R. CHINA. Jilin.** July. 1980. *HMJAU 9589*. Li.

Remarks: The distinct characteristics of this species are the rust brown or red brown sporothecae, short stalks, definite and sturdy ribs and faintly reticulate spores. Nannenga-Bremekamp (1991) showed that there was no reticulum on the spores of the specimens from the Netherlands. The spores of Chinese materials examined have faint reticulation, in agreement with Martin and Alexopoulos (1969).

Cribraria filiformis Nowotny & Neubert, in Neubert, Nowotny & Baumann, Myxom. Deutschl. 1: 77. 1993. FIGURE 2 (5, 6), FIGURE 3 (1, 2)

Sporocarps gregarious, globose, stalked, erect or nodding, ochraceous to dark brown, 0.3-0.7 mm in diameter; net dense, with many free ends; net meshes small; nodes scarcely differentiated, filled with dictydine granules; cup about one-third the height of the sporothecae, metallic, with radially plicate; margin of cup bearing regular teeth; dictydine granules, brownish, 2-3 μm in diameter; stalk dark reddish brown, slender, furrowed, tapered upward, 0.7-1.8 mm long; hypothallus reddish brown or nearly colorless, common to a group; spores ochraceous in mass, pallid by transmitted light, globose, minutely warted, 6.25-7.5 μm in diameter.

Ecology and Distribution: On rotten wood. Know in Inner Mongolia.

SPECIMEN EXAMINED: **P. R. CHINA. Inner Mongolia.** Aug. 1991. *HMAS 91-392,* Li.

Remarks: In the specimen examined, the nodes of peridial net are rarely differentiated and the dense peridial net has many free ends. These characteristics clearly distinguish this species from other *Cribaria species*. In many aspects, such as sporothecae shape, cup size and spore traits, it is easily confused with *C. persoonii* Nann.-Bremek., but the latter has concentrically wrinkled cups and thickened nodes.

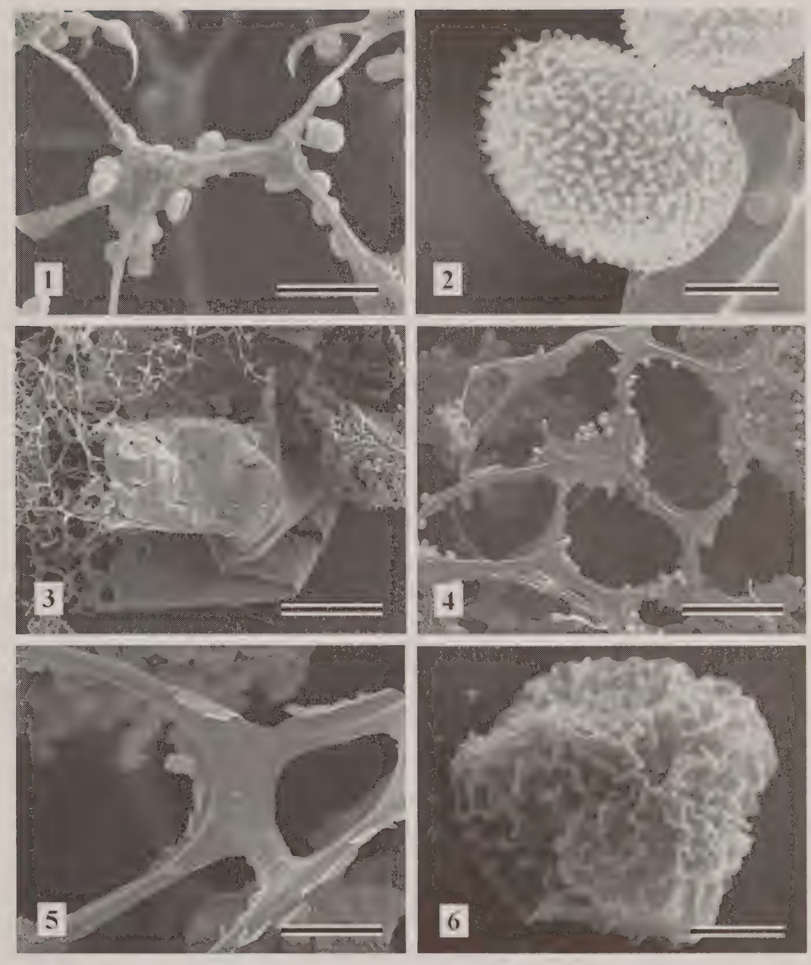

Fig. 3. 1-2. *Cribraria filiformis* (HMAS 91-392). 1. Nodes with threads (Bar = 20μm). 2. Spores (Bar = 2μm). 3-6. *Cribraria macrospora* (HMAS 53731). 3. Peridial net and cup with a stalk (Bar = 300μm). 4. Part of the peridial net (Bar = 60μm). 5. Node with threads (Bar = 20μm). 6. Spores (Bar = 2μm).

Cribraria macrospora Nowotny & Neubert, in Neubert, Nowotny & Baumann, Myxom. Deutschl. 1: 85, 1993. FIGURE 3 (3-6)

Sporocarps gregarious or scattered, stalked, erect, ochraceous, globose or broadly pyriform, 1.2-1.7 mm in diameter, 3.0-3.8 mm tall; net with many short free ends;

nodes flat, slightly expanded, irregular; cup occupying one-fourth of the sporothecae, persistent, with radial ribs and granular lines, with some perforations in the upper part so that it merges gradually with the net; dictydine granules brown, 0.8-1.2 μm in diameter; stalk black, cylindrical, longitudinally furrowed, robust, 1.5-2.3 mm long; hypothallus dark to blackish brown, common to a group; spores ochraceous in mass, brownish by transmitted light, globose, bearing many minute warts by LM, with folds by SEM, 10.0-12.5 μm in diameter.

Ecology and Distribution: On moss. Known in Guangxi and Tibet.

SPECIMENS EXAMINED: **P. R. CHINA. Tibet.** Oct. 1982. *HMAS 53731*,Su. **GUANGXI.** July 1997. *HMAS 75371*, Chen.

Remarks: This species is similar to *Cribraria macrocarpa* Schrad. and *C. meylanii* Brandza in size, shape and habit of sporotheca, cup traits, and stalk structure. However, from the former it differs in its ochraceous sporotheca, thicker threads of peridial nets and ochraceous spore mass, and from the latter, in its ochraceous globose sporotheca, smaller cups and ochraceous warted spores. This species has the largest spores in *Cribraria*.

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Glomus aurantium and *G. xanthium*, new species in Glomeromycota

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Abstract–Two new ectocarpic arbuscular mycorrhizal fungal species, *Glomus aurantium* and *G. xanthium* (Glomeromycota), were discovered in the Mediterranean Sea dunes located in Israel, Greece, Italy, and Majorca, Spain. Mature spores of *G. aurantium* are deep orange, globose to subglobose, (70-)98(-120) µm diam, or ovoid, 80-120 x 110-150 µm. Their wall consists of a permanent, flexible to semiflexible, hyaline outermost layer, easily separating from a laminate, deep orange middle layer, and a flexible, hyaline innermost layer. Spores of *G. xanthium* usually are tightly adherent to roots and frequently occur within roots. They are light yellow to ochre, globose to subglobose, (23-)50(-70) µm diam or ovoid, 20-55 x 45-100 µm, and have a spore wall with a rigid, semi-permanent, hyaline to light yellow outermost layer adherent to a rigid, permanent, hyaline middle layer, and a laminate, light yellow to yellow ochre innermost layer. Both *G. aurantium* and *G. xanthium* formed vesicular-arbuscular mycorrhizae in one-species cultures with *Zea mays*. Analysis of ITS and LSU nuclear rDNA in spores placed *G. aurantium* sequences in the *G. versiforme* group, while *G. xanthium* sequences were aligned with those in *Glomus* Group A.

Key words–molecular phylogeny, nuclear ribosomal DNA, vesicular-arbuscular fungi

Introduction

The plant associations hosting exceptionally abundant and diverse populations of arbuscular mycorrhizal fungi (Glomeromycota) are those colonizing maritime sand dunes (Błaszkowski 1993; Koske 1987; Tadych & Błaszkowski 2000). Many of the described species of these fungi have been originally isolated from dunes (Błaszkowski 2003). Examination of pot trap cultures with rhizosphere soils of plants of coastal areas of the Mediterranean Sea revealed two undescribed species of arbuscular fungi that probably prefer warm sites. They have not been found in ca. 3000 soil samples coming from different dune and non-dune soils of northern Europe (Błaszkowski 2003). These fungi are described here as *Glomus aurantium* and *G. xanthium* spp. nov. based on morphology, ontogenetic patterns of spore differentiation, and molecular properties of spores.

Materials and Methods

Establishment of trap cultures and one-species cultures. Collection of soil samples, establishment of trap and single-species pot cultures, as well as growth conditions generally were as those described previously (Błaszkowski & Tadych 1997). Briefly, rhizosphere soils and roots of sampled plants were collected from a depth of 5-30 cm using a small garden shovel. In the laboratory, about 100-g subsamples were taken from each sample to isolate spores of arbuscular mycorrhizal fungal species sporulating in the field. The remaining part of the sample was either air dried for 2 weeks and subsequently refrigerated at 4°C or directly used to establish trap cultures. Trap cultures were established to obtain a great number of living spores of different developmental stages and to initiate sporulation of species that were present but not sporulating in the field collections. The growing substrate of the trap cultures was the field-collected material mixed with an autoclaved coarse-grained sand coming from maritime dunes adjacent to Świnoujście (pH 6.7; 12 and 26 mg L^{-1} P and K, respectively; Błaszkowski 1995). The mixtures were placed in 9x12.5-cm plastic pots (500 cm^3) and densely seeded with *Plantago lanceolata* L. Plants were grown in a greenhouse at 15-30°C with supplemental 8-16-h lighting provided by one SON-T AGRO sodium lamp (Philips Lighting Poland S. A.) placed 1 m above pots. The maximum light intensity was 180 $\mu E\ m^{-2}s^{-1}$ at pot level. Plants were watered 2-3 times a week. No fertilizer was applied during the growing period. Trap cultures were harvested at approximately 1-month intervals, beginning three months and ending five to seven months after plant emergence. Spores were extracted by wet sieving and decanting (Gerdemann & Nicolson 1963). Presence of mycorrhizae was determined following clearing and staining of roots (Phillips & Hayman 1970) modified as follows: tissue acidification with 20% HCl instead of 1%, and trypan blue concentration 0.1% instead of 0.05% (Koske, pers. comm.).

Single-species pot cultures were established from about 50 to 100 newly formed spores stored before inoculation in water at 4°C for 24 h. After removal of soils debris, spores were collected in a pipette and transferred onto a compact layer of mycorrhizae-free roots of 10-14 day old seedlings of *P. lanceolata* placed at the bottom of a hole *ca.* 1 cm wide and 4 cm deep formed in a wetted growing medium filling 8-cm plastic pots (250 cm^3). The growing medium was an autoclaved sand of maritime dunes adjacent to Świnoujście with chemical properties listed above. Subsequently, the spores were covered with another layer of roots attached to 4-6 additional host plants, and the roots and sandwiched spores were buried in the growing medium. Finally, three to six seeds of *P. lanceolata* were placed on the surface of the growing substrate and covered with a thin layer of autoclaved sand. The cultures were harvested after 4-8 months and spores were extracted. The effectiveness of this method in establishing one-species cultures usually exceeded 90% (Błaszkowski et al. 2002).

Microscopical survey. Morphological properties of spores and their subcellular structures were determined based on at least 100 spores mounted in polyvinyl alcohol/lactic acid/glycerol (PVLG; Koske & Tessier 1983) and a mixture of PVLG and Melzer's reagent (1:1, v/v). Spores at all stages of development were crushed to varying degrees by applying pressure to the coverslip and then stored at 65°C for 24 h to clear their contents of oil droplets. These were examined under an Olympus BX 50 compound microscope equipped with Nomarski differential interference contrast optics. Microphotographs were recorded on a Sony 3CDD color video camera coupled to the microscope.

Terminology of spore structure is that suggested by Spain et al. (1989), Stürmer & Morton (1997), and Walker (1983). Spore color was examined under a dissecting microscope on fresh specimens immersed in water. Color names are from Kornerup & Wanscher (1983). Nomenclature of fungi and plants is that of Walker & Trappe (1993) and Mirek et al. (1995), respectively. The authors of the fungal names are as those presented at the URL web page http://www.indexfungorum.org/AuthorsOfFungalNames.htm. Specimens were mounted in PVLG on slides and deposited in the Department of Plant Pathology (DPP), University of Agriculture, Szczecin, Poland, and in the herbarium at Oregon State University (OSC) in Corvallis, Oregon, USA.

Color microphotographs of spores and mycorrhizae of *G. aurantium* and *G. xanthium* can be viewed at the URL http://www.agro.ar.szcecin.pl/~jblaszkowski/.

PCR amplification. To amplify DNA from single spores, these were separated in a drop of sterile water. The water was removed before spores were crushed, pipetted with 8 μl of the PCR-Mix and used directly for PCR.

Amplification of the analysed ITS and LSU nrDNA region by PCR was performed on a Hybaid Ltd. OmniGene TR3 CM220 Thermo Cycler (MWG-Biotech, Ebersberg, Germany) in a total volume of 50 μl containing 2 U Taq DNA polymerase (Promega, Heidelberg, Germany), 5 μl of 10x Taq polymerase reaction buffer (Promega), 4 μl 25 mM $MgCl_2$, 10 nmol of each dNTP (MBI-Fermentas, St. Leon-Rot, Germany), 50 pmol of each of the two primers and 1 μl of the DNA extract. The reactions were performed as hot start PCR with 10 min initial denaturation at 94°C before adding the Taq polymerase at 80°C. The PCR program comprised 32 cycles (40 s at 94°C, 30 s at 54°C, 40 s at 72°C). A final elongation of 10 min at 72°C followed the last cycle.

SSU-Glom1 (ATT ACG TCC CTG CCC TTT GTA CA) and LSU-Glom1 (C TT CAA TCG TTT CCC TTT CA) previously described by Renker et al. (2003) were used as primers to amplify the target regions.

Cloning, Sequencing and Sequence Analyses. PCR products were cloned into the pCR4-Topo Vector following the manufacturer's protocol of the TOPO TA Cloning Kit (Invitrogen Life Technologies, Karlsruhe, Germany) and transformed into TOP10 Chemically Competent *Escherichia coli*. Sequencing was done using a LI-COR

DNA Sequencer Long Reader 4200 and the Thermo Sequenase fluorescent labeled primer cycle sequencing kit with 7-deaza-dGTP (Amersham Pharmacia Biotech, Little Chalfont, UK).

DNA sequences of the complete ITS and parts of the ribosomal small and large subunit were submitted to the EMBL database under the accession numbers given in Figs. 17 and 18 for *G. aurantium* and *G. xanthium*. Reference sequences to analyze the systematic position of the new sequences were taken from GenBank. In a first step, only the 5.8S subunit genes embedded between the ITS1 and ITS2 regions were aligned by hand to allow an analysis of the systematic position of *G. aurantium* and *G. xanthium* based on a large sequence data set. In a second step, the full-length ITS sequence of *G. xanthium* was aligned with other *Glomus* Group A *sensu* Schüßler et al. (2001) sequences to take a closer look at its systematic position. Furthermore a small sequence data set of available LSU sequences was aligned to ensure the phylogenetic position of the new species. An alignment of the full-length sequences of *G. aurantium* and *G. xanthium* was not possible due to a lack of comparable sequence data from other AMF species, but also due to the high variation within the ITS1 and ITS2 region when comparing sequences from different groups within the Glomeromycota.

Maximum parsimony analyses were performed with PAUP* 4.0b10 (Swofford 2003) using the heuristic search mode with 10 random-addition sequence replicates, tree bisection-reconnection branch swapping, MULTrees option on and collapse zero-length branches off. All characters were treated as unordered and equally weighted. Strict consensus trees were calculated including all MP trees. The confidence of branching was assessed using 1000 bootstrap resamplings.

The data set used to reconstruct the 5.8S phylogenetic tree (Fig. 17) contained 158 characters of which 83 were constant, 18 parsimony uninformative and 57 parsimony informative. The data set used to reconstruct the LSU tree (Fig. 18) contained 357 characters of which 195 were constant, 55 parsimony uninformative and 107 parsimony informative. The full length ITS tree containing *G. xanthium* (Fig. 35) has 572 characters of which 371 were constant, 74 parsimony uninformative and 127 parsimony informative.

Descriptions of the species

Glomus aurantium J. Błaszk., V. Blanke, C. Renker & F. Buscot, sp. nov.

Figs. 1-16

Sporocarpia ignota. Sporae singulae in solo efformatae; pallide luteae vel aurantiae vel ochraceae; globosae vel subglobosae; (70-)98(-120) µm diam; aliquando ovoideae; 80-120 x 110-150 µm. Tunica sporae e stratis tribus (strati 1-3); strato "1" elastico vel semielastico, glabro, hyalino, (0.7-)1.0(-1.5)µm crasso; strato "2" laminato, glabro, pallide luteo, intense aurantio vel aureo, (2.7-)5.8(-8.8) µm crasso; strato "3" elastico, glabro, hyalino, (0.5-)0.7(-1.0) µm crasso. Hypha subtendens pallide luteo, intense aurantio vel aureo; recta vel recurva; cylindrica, raro coliga; (0.5-)0.7(-1.0) µm lata ad basim sporae; pariete pallide luteo, intense aurantio vel aureo; (0.7-)2.0(-4.7) µm crasso, stratis 1-3 sporae continuo. Porus e septo continuo strati 3 sporae efformata. Mycorrhizas vesicular-arbusculares formans.

HOLOTYPUS. POLAND. Szczecin, infra *P. lanceolata*, 10 Jan. 1998, *Błaszkowski, J., 2444* (DPP).

Sporocarps unknown. *Spores* occur singly in the soil (Fig. 1); origin blastically at the tip of extraradical hyphae of mycorrhizal roots. Spores yellowish white (4A2) when young, deep orange (5A7-8) at maturity, to golden yellow (5B8) when older; globose to subglobose; (70-)98(-120) μm diam; sometimes ovoid; 80-120 x 110-150 μm; with a single subtending hypha (Figs. 1, 11, 12). *Subcellular structure of spores* (Figs. 2-12) consists of one wall including three layers (layers 1-3). Outermost layer 1 permanent, flexible to semiflexible, smooth, hyaline, (0.7-)1.0(-1.5) μm thick (Figs. 2-5, 7-12), sometimes ballooning, and then extending up to 30 μm from layer 1 in spores mounted in PVLG (Fig. 3). This layer frequently accumulates a granular material, up to 1.5-7.0 μm thick, composed of soil debris (Figs. 4, 5, 7, 10). Layer 2 laminate, smooth, yellowish white (4A2) to golden yellow (5B8), (2.7-)5.8(-8.8) μm thick (Figs. 2-12). Layer 3 flexible, smooth, hyaline, (0.5-)0.7(-1.3) μm thick (Figs. 2-12), usually tightly adherent to layer 2 and almost always inseparably attached to the inner surface of subtending hyphal wall layer 3, close at the spore base to form a curved septum in the lumen of the subtending hypha (Fig. 11). None of the spore wall layers reacts in Melzer's reagent. *Subtending hypha* yellowish white (4A2) to golden yellow (5B8), straight or recurvate; cylindrical or slightly flared, rarely constricted; (3.2-)7.1(-11.8) μm wide at the spore base (Figs. 11, 12). *Wall of subtending hypha* yellowish white (4A2) to golden yellow (5B8); (0.7-)2.0(-4.7) μm thick at the spore base; continuous with spore wall layers 1-3 (Fig. 11); layers 1 and 3 extend up to 10.0 and 2.0-3.4 μm, respectively, below the spore base. *Pore* occluded by a septum, (2.0-)2.9(-4.2) μm wide, continuous with spore wall layer 3 (Fig. 11) and occasionally also by a septum formed by a few innermost laminae of spore wall layer 2, positioned 3.0-6.5 μm below the spore base (Fig. 12).

Collections examined. HOLOTYPE. POLAND. Szczecin, from under pot-cultured *P. lanceolata*, 6 Jul. 2003, *Błaszkowski, J., 2444* (DPP); isotypes: *Błaszkowski, J., 2445-2459* (DPP) and two slides at OSC.

Other material examined. ISRAEL. Near Tel-Aviv (32°4'N, 34°46'E), from the root zone of *Cenothera drummondi* Hook, 16 Dec. 1997 and 15 June 2000 and *Ammophila arenaria* (L.) Link, 15 June 2000, *Błaszkowski, J., unnumbered collection* (DPP). SPAIN. Near Cape Salinas (36°19'N, 3°2'E) and Sóller (39°46'N, 2°40'E), Majorca, from around roots of *A. arenaria*, 15 Aug. 2001, *Błaszkowski, J.*, unnumbered collection (DPP). ITALY. Near Calambrone (43°35'N, 10°18'E), from under *A. arenaria*, 11 Oct. 2002, *Błaszkowski, J.*, unnumbered collection (DPP).

Etymology. Aurantium, referring to the orange-golden-colored spores.

Distribution and habitat. Glomus aurantium was discovered in a trap culture with a rhizosphere soil of *C. drummondi* colonizing dunes of the Mediterranean Sea adjacent to Tel-Aviv in December 1997. This fungus also sporulated in 60 other trap cultures with dune rhizosphere soils of *A. arenaria* and *C. drummondi* sampled near Tel-Aviv in 1997 (9 samples) and 2000 (51). Later, spores of *G. aurantium* were isolated from eight trap cultures established from soils collected under *A. arenaria* growing near Cape Salinas and Sóller, Majorca, Spain, and seven trap cultures containing rhizosphere soil and root mixtures taken from under *A. arenaria* growing in dunes adjacent to Calambrone, Italy.

The arbuscular fungi accompanying *G. aurantium* in the field were *G. constrictum* Trappe and *G. coronatum* Giovann. The fungi co-occurring with *G. aurantium* in trap cultures with Israeli soils were *Acaulospora paulinae* Błaszk., *Archaeospora trappei* (R.N. Ames & Linderman) J.B. Morton & D. Redecker, *G. arenarium* Błaszk. et al., *G. constrictum*, *G. coronatum*, *G. corymbiforme* Błaszk., *G. dominikii* Błaszk., *G. gibbosum* Błaszk., *G. mosseae* (Nicol. & Gerd.) Gerd. & Trappe, *G. xanthium* Błaszk. et al., an undescribed *Glomus* sp., *S. calospora* (Nicol. & Gerd.) C. Walker & F.E. Sanders, and *S. persica* (Koske & C. Walker) C. Walker & F.E. Sanders. Apart from *G. aurantium*, the Majorca's cultures contained *G. constrictum*, *G. coronatum*, *G. dominikii*, *G. macrocarpum* Tul. & C. Tul., two undescribed *Glomus* spp., *S. calospora*, and *S. persica*. The cultures representing Italy still hosted *Ac. scrobiculata* Trappe, *Entrophospora schenckii* Sieverd. & S. Toro, *G. constrictum*, *G. dominikii*, two undescribed *Glomus* spp., *S. fulgida* Koske & C. Walker, and *S. persica*.

Mycorrhizal associations. *Glomus aurantium* was associated in the field with vesicular-arbuscular mycorrhizae of *A. arenaria* in Israel, Majorca, Spain, and Italy, as well as with those of *C. drummondi* growing in Israel.

In one-species cultures with *Z. mays* as the host plant, mycorrhizae of *G. aurantium* consisted of arbuscules, vesicles, as well as intra- and extraradical hyphae (Figs. 13-16). Arbuscules generally were numerous and evenly distributed along root fragments (Fig. 13). Vesicles occurred very abundantly and were globose to subglobose; (18-)32(-45) μm diam; sometimes ellipsoid; 20-40 x 55-110 μm (Fig. 14). Intraradical hyphae were (1.0-)4.8(-7.4) μm wide and grew parallel to the root axis (Fig. 15). They were straight or slightly curved, sometimes formed Y- or H-shaped branches and coils (Fig. 16). The coils were 12.5-50.0 x 22.5-140.0 μm. Extraradical hyphae were (2.5-)4.0(-4.7) μm wide. Their abundance varied, depending on the root fragments examined. In 0.1% trypan blue, arbuscules stained violet white (16A2) to lilac (16B4), vesicles violet white (19A2) to deep blue (19E6), intraradical hyphae violet white (16A2) to

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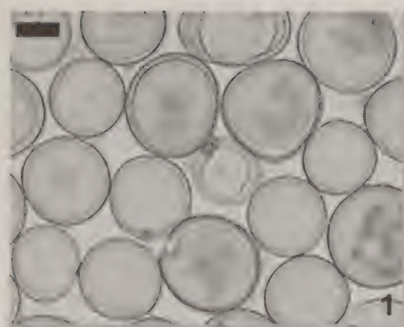
Figs. 1-16. Spores of *Glomus aurantium* and its mycorrhizae in roots of *Zea mays* stained in 0.1% trypan blue. **1.** Mature spores. 2. Adherent spore wall layers 1 (swl1) and 2 (swl2) and spore wall layer 3 (swl3) slightly separated from spore wall layer 2. **3.** Ballooned spore wall layer 1 (swl1) locally separated from spore wall layer 2 (swl2) and spore wall layer 3 (swl3). **4-10.** Spore wall layers (swl) 1-3 and soil debris (sd) accumulated by spore wall layer 1. **11.** Subtending hyphal wall layers 1 (shwl1) and 2 (shwl2) continuous with spore wall layers 1 (swl1) and 2 (swl2); curved septum formed by invaginated spore wall layer 3 (swl3) is visible. **12.** Spore wall layers (swl) 1-3 and subtending hypha with septum (s) continuous with the innermost laminae of spore wall layer 2. **13.** Arbuscules (arb) and arbuscule trunk (tr) developed from intraradical hypha (hyp). **14.** Vesicles (ves). **15.** Straight (shyp), H-(Hb), and Y-(Yb) branched intraradical hyphae. **16.** Coils. Fig. 1., intact spores in water. Fig. 2, spore crushed in PVLG. Figs. 3-12, spores crushed in PVLG+Melzer's reagent. Figs. 13-16, mycorrhizae in PVLG. Figs. 1 and 13-16, bright field microscopy; Figs. 2-12, differential interference contrast. Bars: Fig. 1=50 μm, Figs. 2-16=10 μm.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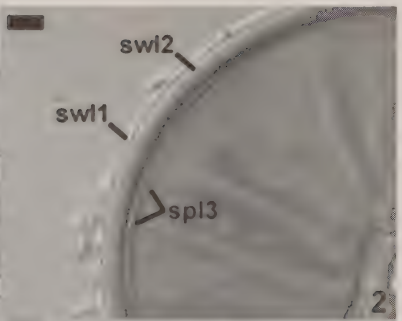
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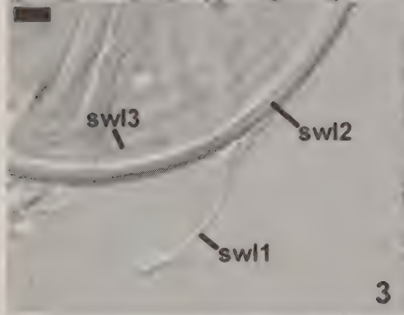
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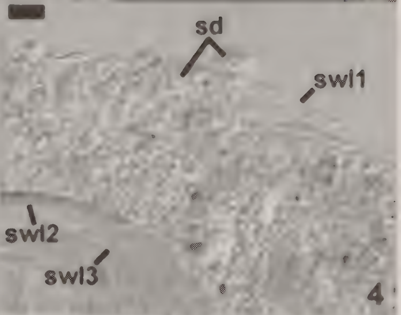
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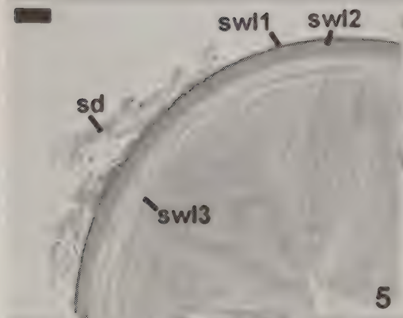
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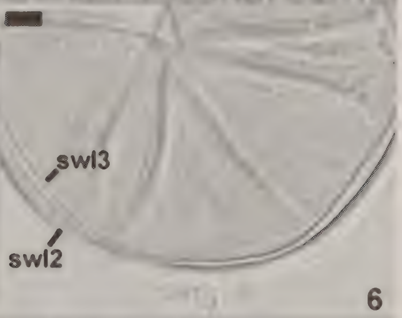
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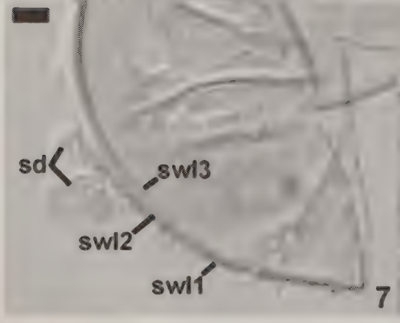
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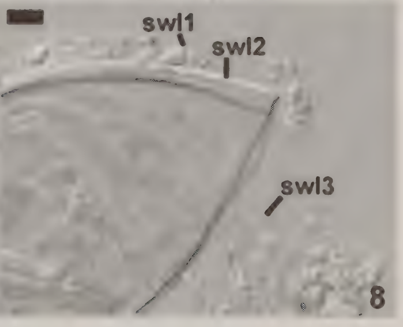
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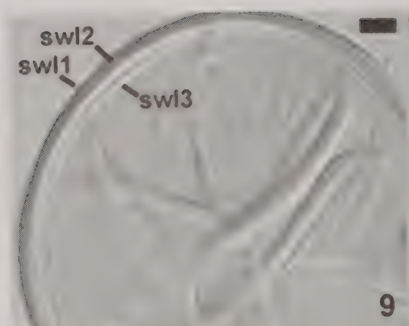
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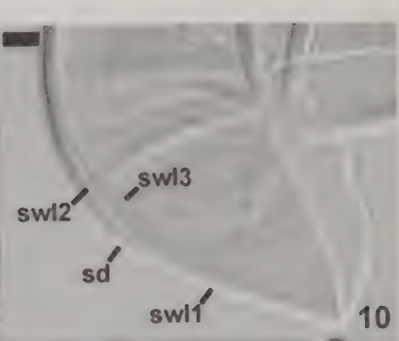
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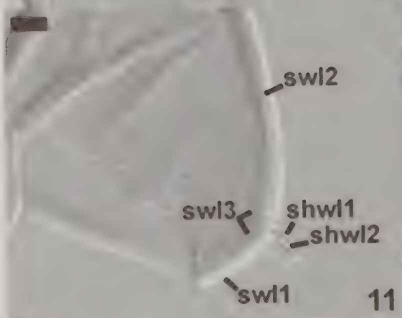
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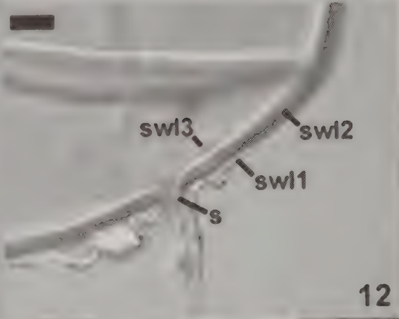
11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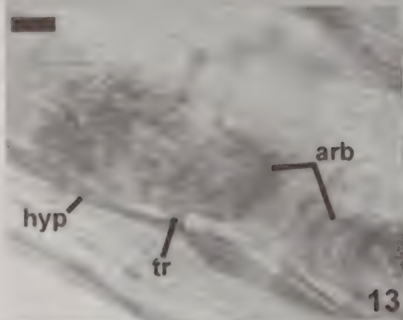

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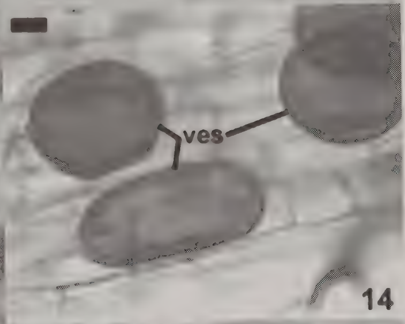

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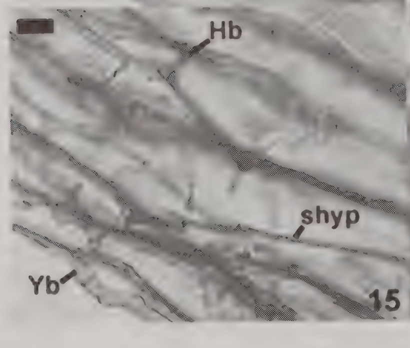

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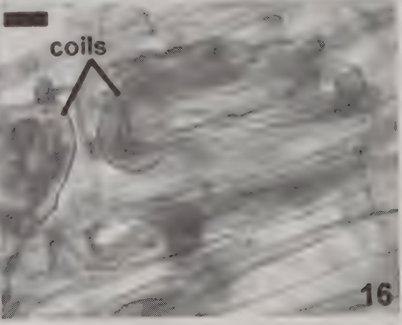


16

reddish violet (16C8), coils pale violet (16A3) to reddish violet (16B6), and extraradical hyphae light lilac (16A5) to royal purple (16D8).

Phylogenetic position. The analysis of the 5.8S gene within the ITS region revealed a close relationship between *G. aurantium* and *G. versiforme* (P. Karsten) S.M. Berch (Fig. 17). In the LSU tree, *G. aurantium* is the terminal taxon of a not supported lineage placed sister to the *Glomus* Group A (Fig. 18). Comparing the full length ITS sequences of *G. aurantium* with sequences assigned to *G. versiforme* available in GenBank, the molecular similarity of the two fungi ranged from 89 to 92% (Table 1).

Table 1. Comparison of the *Glomus aurantium* ITS nrDNA sequence with GenBank sequences

Sequences from GenBank	**Identity** [%]	**# bp aligned** (with gaps)	**# variable positions**	**# of gaps**
Glomus versiforme AF246141	91	548	41	11
Glomus versiforme AF246142	89	550	49	11
Glomus versiforme AF246143	90	550	41	12
Glomus versiforme AJ504642	90	559	34	22
Glomus versiforme AJ504643	92	555	24	21
Glomus versiforme AJ504644	91	547	36	11
Uncultured *Glomus* AY236283	85	561	57	29

Column 2 - the identity of the *Glomus aurantium* ITS sequence (between the priming sites of the ITS1/ITS4 primer) with the sequence mentioned in column 1 (calculated as the value in column 3 minus the values in columns 4 and 5 divided by the value in column 3); column 3 - the number of base pairs of the paired sequence alignments between our sequences and the corresponding sequence of column 1; column 4 - the number of variable positions; column 5 - the number of gaps in these alignments

Discussion. Glomus aurantium most distinguishes its orange-colored spores and their wall structure. In the 3-layered spore wall, the structures most distinctive are the flexible to semi-flexible permanent outermost layer 1, which sometimes balloons in lactic acid-based mountants, and the flexible innermost layer 3. None of the three layers stains in Melzer's reagent.

When viewed under a dissecting microscope, spores of *G. aurantium* most resemble those of *G. pustulatum* Koske et al. and *G. versiforme* because of their orange pigmentation and a similar size range (Błaszkowski 2003; Koske et al. 1986; Morton 2000). Younger, yellow-colored spores of *G. aurantium* are also reminiscent of those of *G. claroideum* N.C. Schenck & S.M. Sm., *G. fasciculatum* (Thaxt.) Gerd. & Trappe emend. C. Walker & Koske, *G. lamellosum* Dalpé et al., and *G. luteum* L.J. Kenn. et al.

Examination of spores crushed in PVLG and PVLG mixed with Melzer's reagent under a compound microscope readily separates *G. aurantium* from the six species listed above. Although both *G. aurantium* and *G. pustulatum* produce spores with a wall consisting of three permanent layers, the outermost layer of the former species is smooth or covered with granular debris and that of *G. pustulatum* is ornamented with blistery, cup- or irregularly-shaped processes (Błaszkowski 2003; Koske et al. 1986).

The character most distinguishing *G. versiforme* from *G. aurantium* is the lack of the innermost flexible spore wall layer of the latter species (Błaszkowski 2003; Morton 2000). Additionally, the outermost spore wall layer in *G. aurantium* is permanent, and that of *G. versiforme* degrades with age.

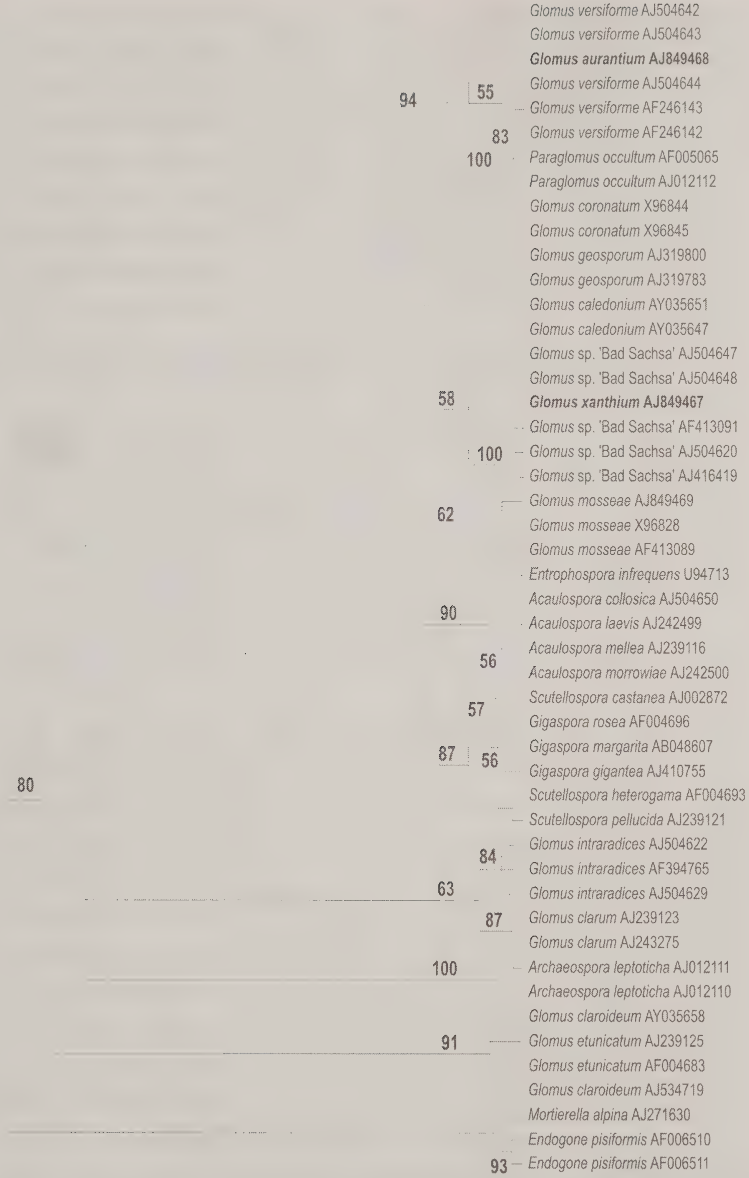
The spore wall of *G. fasciculatum* and *G. lamellosum* also consists of three layers (Błaszkowski 2003; Błaszkowski et al. 2002; Dalpé et al. 1992; Walker & Koske 1987). Moreover, in *G. fasciculatum*, these layers are persistent and have similar phenotypic properties as those of *G. aurantium*. However, two outer spore wall layers of the former species stain red in Melzer's reagent, whereas all three wall layers of *G. aurantium* spores remain non-reactive in this reagent. Additionally, the outermost spore wall layer of *G. fasciculatum* does not accumulate debris as that of *G. aurantium* and spores of the former fungus frequently occur in aggregates (vs. only single spores in *G. aurantium*).

In contrast to the outermost persistent layer and the innermost in-amyloid layer of spore wall of *G. aurantium*, the outermost wall layer of spores of *G. lamellosum* degrades with age and their innermost layer stains pinkish in Melzer's reagent (Błaszkowski 2003; Błaszkowski et al. 2002; Dalpé et al. 1992; Morton 2000).

Glomus aurantium differs from *G. claroideum* and *G. luteum* in the number of spore wall layers, as well as in their phenotypic and biochemical properties. Spores of *G. claroideum* and *G. luteum* have a penultimate laminate wall layer and an innermost flexible wall layer of spores of *G. aurantium* (Błaszkowski et al. 2003; Kennedy et al. 1999; Schenck & Smith 1982; Stürmer & Morton 1997; Walker & Vestberg 1998). However, the laminate layer in *G. aurantium* is surrounded with only one permanent layer, whereas that of the former two species is covered with two layers, of which each degrades and sloughs with age. Finally, the outermost spore wall layer of *G. claroideum* and *G. luteum* stains pink to purplish red in Melzer's reagent, but remains non-reactive in *Gl. aurantium*.

The accumulation of soil debris on the surface of mature spores of *G. aurantium* is a property that also distinguishes spores of *G. viscosum* Nicol., another species producing spores of a similar structure of their wall and a size range (Morton 2000; Walker et al. 1995). However, spores of *G. viscosum* are much lighter-colored (subhyaline to pale yellow vs. yellowish white to golden yellow in *G. aurantium*) and frequently occur in aggregates (vs. only singly in *G. aurantium*).

The molecular analysis of the 5.8S gene confirmed a close relationship of *G. aurantium* with *G. versiforme* (Fig. 17, Table 1). Based on sequence data from the ribosomal small subunit (SSU), *G. etunicatum* W.N. Becker & Gerd. (isolate W3239/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Glomus versiforme AJ504643
Glomus aurantium AJ849468
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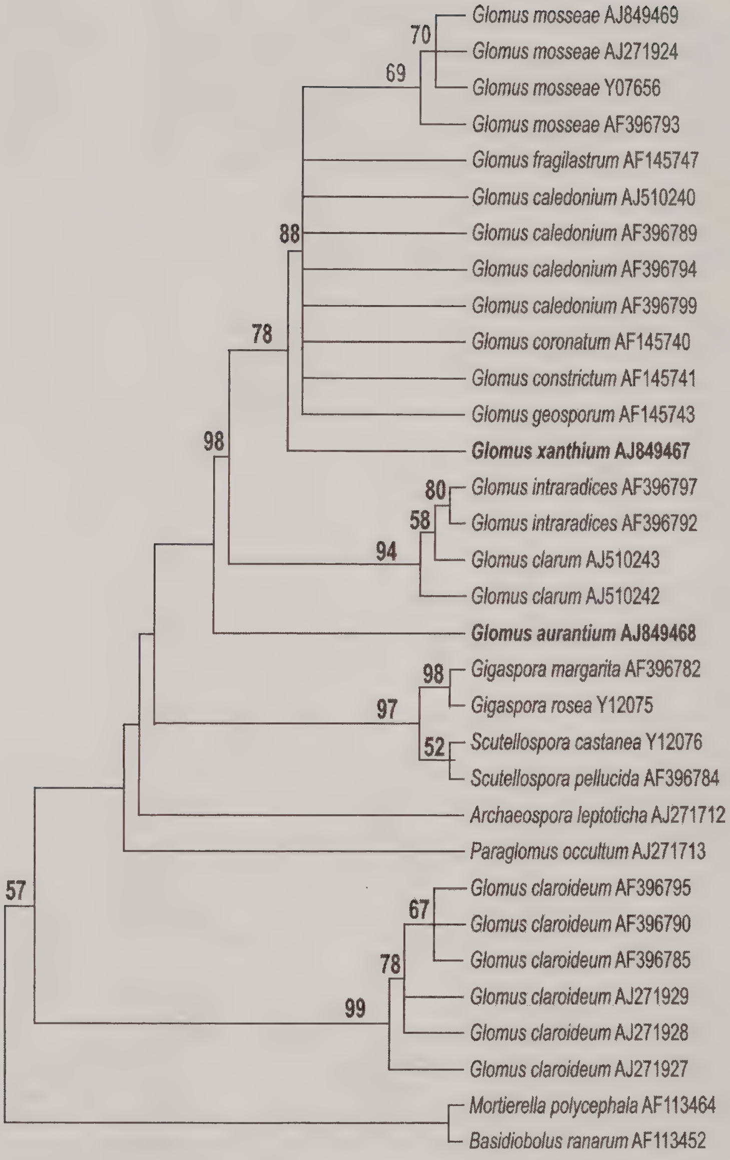
Glomus versiforme AJ504644
Glomus versiforme AF246143
83
Glomus versiforme AF246142
100
Paraglomus occultum AF005065
Paraglomus occultum AJ012112
Glomus coronatum X96844
Glomus coronatum X96845
Glomus geosporum AJ319800
Glomus geosporum AJ319783
Glomus caledonium AY035651
Glomus caledonium AY035647
Glomus sp. 'Bad Sachsa' AJ504647
Glomus sp. 'Bad Sachsa' AJ504648
58
Glomus xanthium AJ849467
Glomus sp. 'Bad Sachsa' AF413091
100
Glomus sp. 'Bad Sachsa' AJ504620
Glomus sp. 'Bad Sachsa' AJ416419
Glomus mosseae AJ849469
62
Glomus mosseae X96828
Glomus mosseae AF413089
Entrophospora infrequens U94713
Acaulospora collosica AJ504650
90
Acaulospora laevis AJ242499
Acaulospora mellea AJ239116
56
Acaulospora morrowiae AJ242500
Scutellospora castanea AJ002872
57
Gigaspora rosea AF004696
Gigaspora margarita AB048607
87
56
Gigaspora gigantea AJ410755
80
Scutellospora heterogama AF004693
Scutellospora pellucida AJ239121
Glomus intraradices AJ504622
84
Glomus intraradices AF394765
63
Glomus intraradices AJ504629
87
Glomus clarum AJ239123
Glomus clarum AJ243275
100
Archaeospora leptoticha AJ012111
Archaeospora leptoticha AJ012110
Glomus claroideum AY035658
91
Glomus etunicatum AJ239125
Glomus etunicatum AF004683
Glomus claroideum AJ534719
Mortierella alpina AJ271630
Endogone pisiformis AF006510
93
Endogone pisiformis AF006511

Fig. 17. Strict Consensus Tree of the Glomeromycota based on 49 5.8S sequences of the nrDNA. Phylogenetic positions of the newly described *Glomus aurantium* and *G. xanthium* are given in bold. Numbers above branches give bootstrap support derived from 1000 replicates. Sequences of *Mortierella alpine* and *Endogone pisiformis* were used as outgroups.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97
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67
78
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Glomus mosseae Y07656
Glomus mosseae AF396793
Glomus fragilastrum AF145747
Glomus caledonium AJ510240
Glomus caledonium AF396789
Glomus caledonium AF396794
Glomus caledonium AF396799
Glomus coronatum AF145740
Glomus constrictum AF145741
Glomus geosporum AF145743
Glomus xanthium AJ849467
Glomus intraradices AF396797
Glomus intraradices AF396792
Glomus clarum AJ510243
Glomus clarum AJ510242
Glomus aurantium AJ849468
Gigaspora margarita AF396782
Gigaspora rosea Y12075
Scutellospora castanea Y12076
Scutellospora pellucida AF396784
Archaeospora leptoticha AJ271712
Paraglomus occultum AJ271713
Glomus claroideum AF396795
Glomus claroideum AF396790
Glomus claroideum AF396785
Glomus claroideum AJ271929
Glomus claroideum AJ271928
Glomus claroideum AJ271927
Mortierella polycephala AF113464
Basidiobolus ranarum AF113452

Fig. 18. Strict Consensus Tree of the Glomeromycota based on 34 partial 28S sequences (large subunit) of the nrDNA. Phylogenetic positions of the newly described *Glomus aurantium* and *G. xanthium* are in bold. Numbers above branches give bootstrap support derived from 1000 replicates. *Mortierella polycephala* and *Basidiobolus ranarum* sequences were used as outgroups.

Att382-16) and *G. spurcum* C.M. Pfeiff., C. Walker & Bloss emend. L.J. Kenn. et al. also clustered phylogenetically next to *G. versiforme* (Schüßler et al. 2001). However, Schüßler et al. (2001) showed some SSU sequences of *G. etunicatum* (isolate UT 316) that rather clustered in *Glomus* Group B, which was also the case for ITS sequences of *G. etunicatum* from GenBank used in our study (Fig. 17). Unfortunately, LSU sequence data of *G. versiforme*, *G. etunicatum*, and *G. spurcum* to further assess and confirm the phylogenetic position of *G. aurantium* are missing and therefore *G. aurantium* formed a single lineage in the LSU phylogenetic tree presented here (Fig. 18). Finally, comparing morphological properties of the four fungi listed above, only *G. aurantium* produces spores having an innermost flexible layer in their wall structure (Błaszkowski 2003; Morton 2000).

Glomus xanthium J. Błaszk., V. Blanke, C. Renker & F. Buscot, sp. nov.

Figs. 19-34

Sporocarpia ignota. Sporae singulae in solo efformatae; pallide luteae vel ochraceae; globosae vel subglobosae; (23-)50(-70) µm diam; aliquando ovoideae; 20-55 x 45-100 µm. Tunica sporae e stratis tribus (strati 1-3); strato "1" rigido, glabro, hyalino vel pallide luteo, (1.2-)1.8(-2.7) µm crasso; strato "2" semielastico, hyalino, (0.2-)0.8(-1.2) µm crasso; strato "3" laminato, glabro, pallide luteo vel ochraceo, (0.7-)1.6(-2.2) µm crasso. Hypha pallide lutea vel ochracea; recta vel recurva; cylindrica vel infundibuliforma, raro coliga; (2.7-)5.6(-9.1) µm lata ad basim sporae; pariete pallide luteo vel ochraceo; (0.5-)0.9(-1.5) µm crasso, stratis 1-3 sporae continuo. Porus e septo continuo strati 3 sporae efformata. Arbuscular mycorrhizae formans.

HOLOTYPUS. POLAND. Szczecin, infra *Plantago lanceolata* L., 10 Jan. 1998, *Błaszkowski, J., 2202* (DPP).

Sporocarps unknown. Spores occur singly in the soil (Fig. 19) and usually are closely adherent to roots (Fig. 20), as well as frequently form within roots (Fig. 21); origin blastically at the tip of extraradical hyphae of mycorrhizal roots. *Spores* light yellow (4A4) to yellow ochre (5C7); globose to subglobose; (23-)50(-70) µm diam; sometimes ovoid; 20-55 x 45-100 µm; with a single subtending hypha (Figs. 19-24, 30). *Subcellular structure of spores* (Figs. 22-29) of one wall with three layers (layers 1-3). Outermost layer 1 rigid, smooth, hyaline, ca. 0.5 µm thick, continuous with a one-layered subtending hypha of the most juvenile spores, then darkening to light yellow (4A4) and thickening to (1.2-)1.8(-2.7) µm (Figs. 22-29). Layer 2 rigid, smooth, hyaline, (0.2-)0.8(-1.2) µm thick (Figs. 22-29), closely adherent to layer 1. In mature spores, layer 1 sometimes more or less deteriorates with age (Figs. 28 and 29), whereas layer 2 always remains intact. Layer 3 laminate, smooth, light yellow (4A4) to yellow ochre (5C7), (0.7-)1.6(-2.2) µm thick (Figs. 22-29). In crushed spores, layers 1 and 2 usually are adherent (Figs. 22-26, 28 and 29) or sometimes separate from each other (Fig. 27). However, the two layers easily separate from layer 3 (Figs. 22-29). None of the spore wall layers reacts in Melzer's reagent. The wall of youngest spores consists of layer 1 only. Then, layer 2 origins, and layer 3 begins to form after a full differentiation of layer 2. *Subtending_hypha* light yellow (4A3) to yellow ochre (5C7); straight or recurvate; cylindrical or flared (Figs. 24, 30), rarely constricted; (2.7-)5.6(-9.1) µm wide at the spore base. *Wall of subtending hypha* light yellow (4A4) to yellow ochre

(5C7); (0.5-)0.9(-1.5) μm thick at the spore base; continuous with spore wall layers 1—3 (Fig. 30); spore wall layers 1 and 2 extend up to 70 μm below the spore base. *Pore* occluded by a septum, 1.2-2.7 μm wide, continuous with the innermost lamina of spore wall layer 3 (Fig. 30).

Collections examined. HOLOTYPE. POLAND. Szczecin, under pot-cultured *P. lanceolata*, 10 Jan. 1998, *Błaszkowski, J., 2202* (DPP); ISOTYPES: *Błaszkowski, J. 2203-2223* (DPP) and two slides at OSC.

Other material examined. ISRAEL. Near Tel-Aviv (32°4'N, 34°46'E), from the root zone of *C. drummondi*, 16 Dec. 1997 and 15 June 2000, *Błaszkowski, J., unnumbered collection* (DPP). SPAIN. Near Cape Salinas (36°19'N, 3°2'E), Majorca, from around roots of *A. arenaria*, 15 Aug. 2001, *Błaszkowski, J.*, unnumbered collection (DPP). TURKEY. Near Karabucak-Tuzla (36°43'N, 34°59'E), from among roots of *A. arenaria*, 7 June 2001, *Błaszkowski, J.*, unnumbered collection (DPP). ITALY. Near Calambrone (43°35'N, 10°18'E), from under *A. arenaria*, 11 Oct. 2002, *Błaszkowski, J.*, unnumbered collection (DPP).

Etymology. Xanthium, referring to the plant species with which this fungus was originally associated.

Distribution and habitat. Spores of *G. xanthium* were for the first time isolated from a trap culture established with a soil sample collected under *Xanthium* cf. *spinosum* L. colonizing maritime sand dunes adjacent to Veriko in northern Greece (22°35'E, 40°08'N). This fungus was not found in the field-sampled soil. The fungi occurring in the field soil from which *G. xanthium* inoculum originated included two unrecognized *Glomus* spp. and *S. persica*. The arbuscular mycorrhizal fungal species associated with *G. xanthium* in trap cultures were *G. clarum* Nicol. & N.C. Schenck, *G. gibbosum*, and an undescribed *Glomus* sp.

Subsequently, this fungus was revealed in 15 trap cultures with rhizosphere soils of other dune sites of the Mediterranean Sea. They were collected from under *C. drummondi* growing near Tel-Aviv, Israel, in 1997 (one sample) and 2000 (7 samples), from among roots of *A. arenaria* growing near Cape Salinas, Majorca, Spain, in 2001 (2 samples), from under *A. arenaria* growing near Karabucak-Tuzla, Turkey, in 2001 (4 samples), and under *A. arenaria* growing near Calambrone, Italy, in 2002 (one

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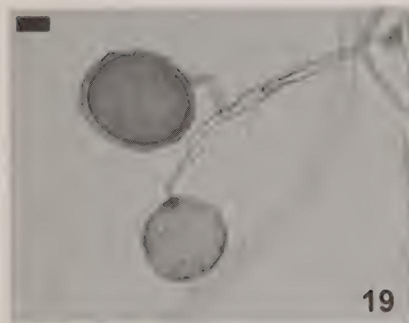
Figs. 19-34. Spores of *Glomus xanthium* and its mycorrhizae in roots of *Zea mays* stained in 0.1% trypan blue. **19.** Extraradical spores with halo formed by spore wall layers 1 and 2. **20.** Spores closely associated with root. 21. Intraradical spores. **22-26.** Adherent spore wall layers 1 (swl1) and 2 (swl2) separated from spore wall layer 3 (swl3). **27.** Spore wall layers (swl) 1-3 separated from each other. **28 and 29.** Highly deteriorated spore wall layer 1 (swl1) adherent to spore wall layer 2 (swl2) separated from spore wall layer 3 (swl3). **30.** Subtending hyphal wall layers (shwl) 1-3; curved septum (s) is visible. **31.** Arbuscules (arb). **32.** Arbuscule (arb), vesicle (ves), and coils of intraradical hyphae. **33.** Vesicles (ves). **34.** Straight (shyp) and coiled (chyp) intraradical hyphae. Figs. 19 and 20, intact spores in water. Fig. 21. Root with spores in PVLG. Figs. 22-24 and 27-30, spores crushed in PVLG. Figs. 25 and 26, spores crushed in PVLG+Melzer's reagent. Figs. 31-34, mycorrhizae in PVLG. Figs. 19-21 and 31-34, bright field microscopy; Figs. 22-30, differential interference contrast. Bars: Fig. 19=20 μm, Figs. 20 and 21=50 μm, Figs. 22-34=10 μm.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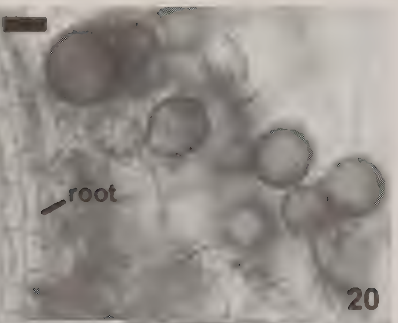

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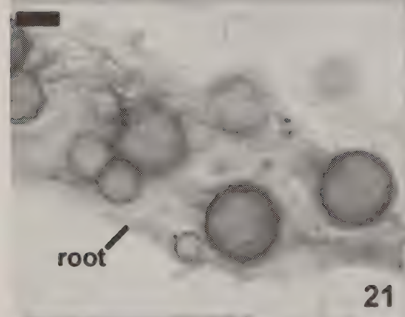

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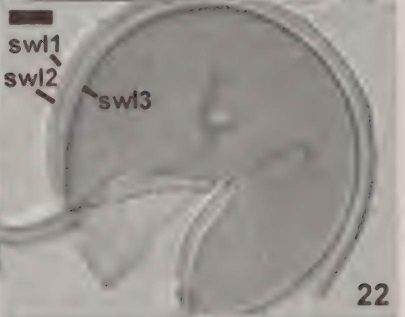
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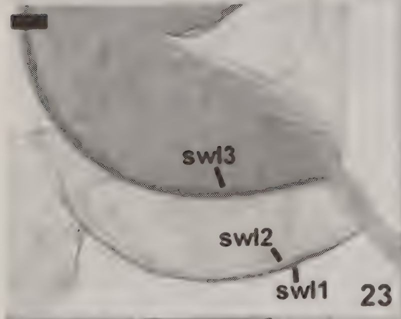
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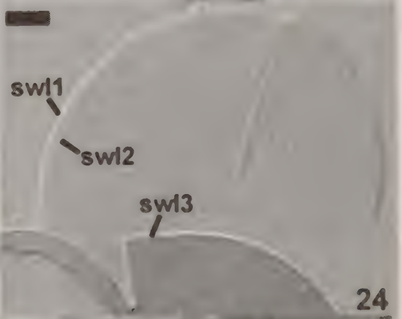
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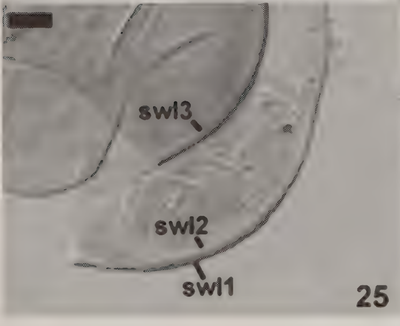
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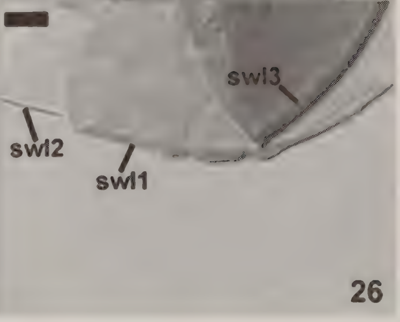
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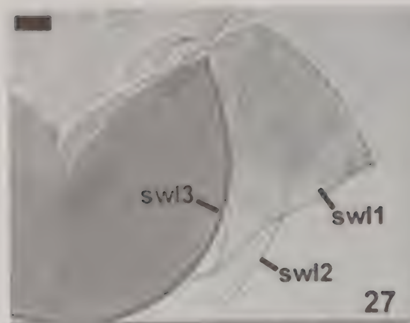
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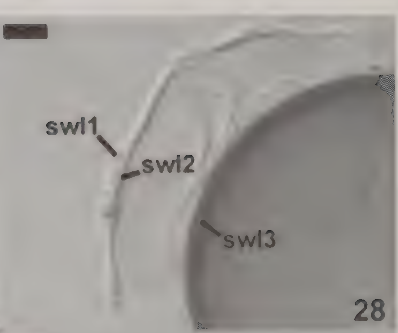
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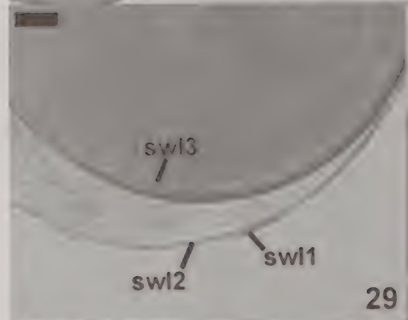
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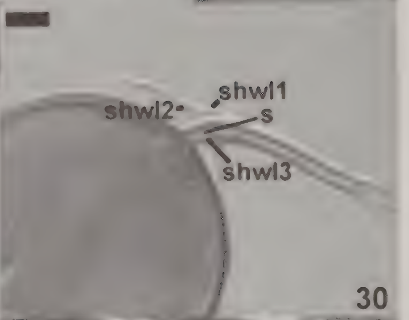
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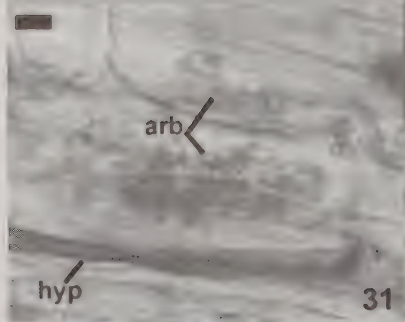

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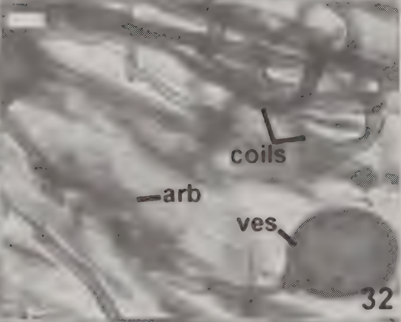
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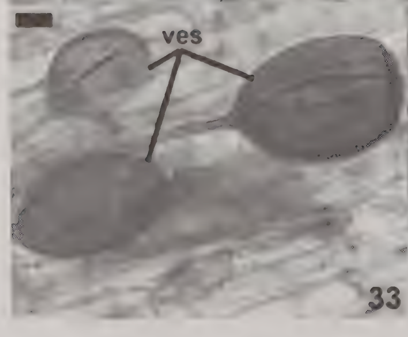

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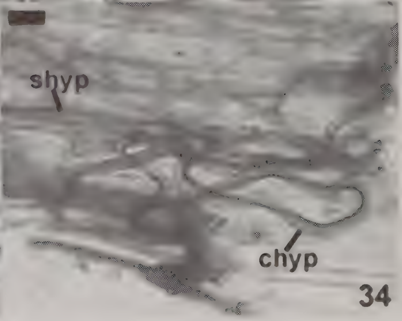

34

sample). No study of the composition of arbuscular mycorrhizal fungal species in the field-collected soils was undertaken. The arbuscular mycorrhizal fungi co-occurring with *G. xanthium* in the trap cultures with Israeli soils were *Archaeospora trappei*, *G. constrictum*, *G. dominikii*, *G. claroideum*, *G. coronatum*, and *Scutellospora pellucida* (Nicol. & N.C. Schenck) C. Walker & F.E. Sanders. The Majorca's cultures contained *Ar. trappei*, *G. constrictum*, *G. corymbiforme*, *S. calospora*, those from Turkey *G. constrictum*, *G. coronatum*, *G. fasciculatum*, *G. aurantium*, and *S. calospora*, and those from Italy *Acaulospora bireticulata* F.M. Rothwell & Trappe, *G. aurantium*, *G. microcarpum* Tul. & C. Tul., and *S. persica.*

The chemical properties of the original soils were not determined.

Mycorrhizal associations. Glomus xanthium was associated in the field with vesicular-arbuscular mycorrhizae of *X.* cf. *spinosum* in Greece, *C. drummondi* in Israel, and *A. arenaria* in Spain and Turkey. In one-species cultures with *Z. mays* as the host plant, *G. xanthium* formed mycorrhizae with arbuscules, vesicles, as well as intra- and extraradical hyphae (Figs. 31-34). Arbuscules were numerous and generally evenly distributed along the root fragments examined (Fig. 31). Vesicles occurred numerously and were globose to subglobose, (20-)27(-40) μm diam, or ellipsoid, 17.5-40.0 x 22.5-120 μm (Figs. 32 and 33). Intraradical hyphae varied in thickness from (0.9-)5.9(-12.7) μm, grew parallel to the root axis, and sometimes formed Y- or H-shaped branches and coils, 12.5-27.5 x 17.5-55.0 μm (Figs. 31, 32 and 34). Extraradical hyphae were abundant, frequently associated with spores, and measured (3.2-)4.7(-7.4) μm wide. In 0.1% trypan blue, arbuscules stained violet white (16A2) to deep violet (16D8), vesicles violet white (16A2) to deep violet (16E8), intraradical hyphae violet white (16A2) to deep violet (16E8), coils violet white (16A2) to reddish violet (16B6), and extraradical hyphae deep violet (16D8-E8).

Phylogenetic position. Sequence data and phylogenetic analyses placed *Glomus xanthium* in *Glomus* Group A *sensu* Schüßler et al. (2001). Sequences of *G. xanthium* fell into a separate cluster (Fig. 17) or even formed a separate lineage (Fig. 18) within *Glomus* Group A, distinct from all well known species of this group (e.g. *G. mosseae*, *G. coronatum*, *G. caledonium* (Nicol. & Gerd.) Trappe & Gerd., *G. geosporum* (Nicol. & Gerd) C. Walker). However, *G. xanthium* clustered close to a preliminarily named *Glomus* sp. 'Bad Sachsa' (with no further correlation to morphological features) from a gypsum slope of the southern Harz mountains (Germany; Renker et al. 2003, Börstler et al. unpubl. data), displaying identities between 90 and 94% (Fig. 35).

Discussion. Two properties mainly distinguish *G. xanthium* from other *Glomus* species. First, spores of the new fungal species tend to form within or tightly adherent to roots (Figs. 20 and 21). Second, the spores are relatively small, with the outermost layer usually thicker than the innermost layer of the 3-layered spore wall (Figs. 19, 22-24, 27).

The pattern of spore wall differentiation in *G. xanthium* is similar to that of *Glomus* species investigated to date (Błaszkowski 1997; Błaszkowski & Tadych 1997; Morton 1996; Stürmer & Morton 1997), with discrete layers formed successively.

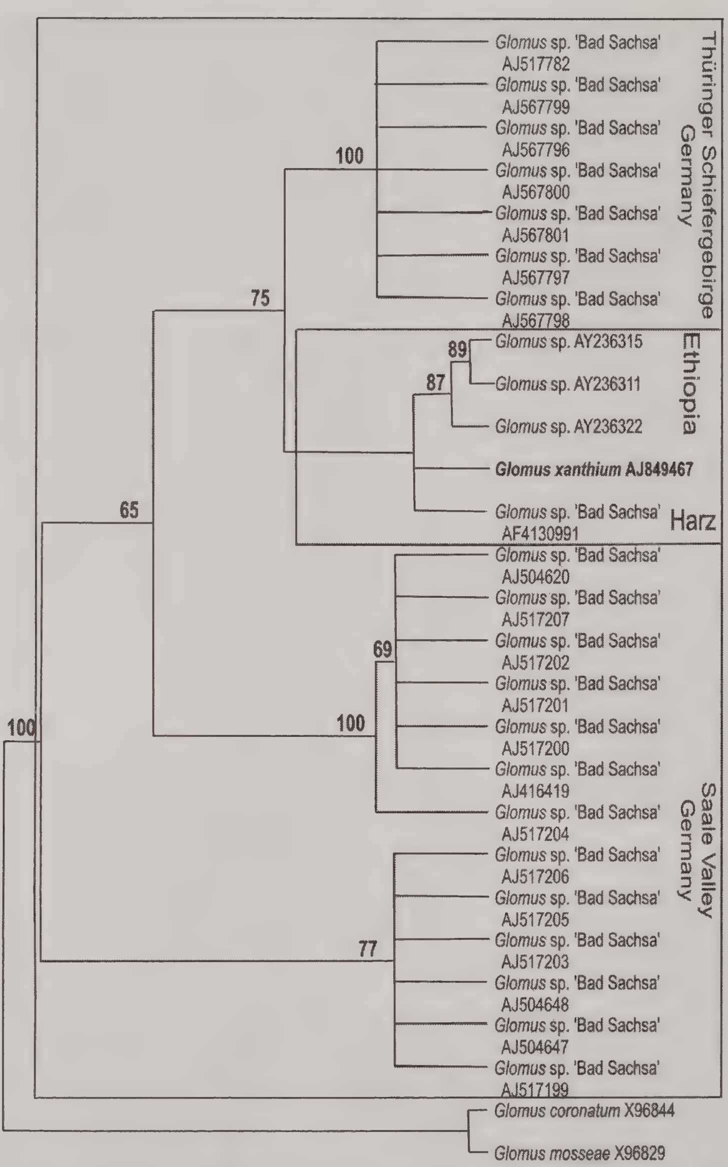
Glomus sp. 'Bad Sachsa' AJ517782
Glomus sp. 'Bad Sachsa' AJ567799
Glomus sp. 'Bad Sachsa' AJ567796
Glomus sp. 'Bad Sachsa' AJ567800
Glomus sp. 'Bad Sachsa' AJ567801
Glomus sp. 'Bad Sachsa' AJ567797
Glomus sp. 'Bad Sachsa' AJ567798
Thüringer Schiefergebirge Germany
100
75
89
87
Glomus sp. AY236315
Glomus sp. AY236311
Glomus sp. AY236322
Ethiopia
Glomus xanthium AJ849467
Glomus sp. 'Bad Sachsa' AF4130991
Harz
65
Glomus sp. 'Bad Sachsa' AJ504620
Glomus sp. 'Bad Sachsa' AJ517207
Glomus sp. 'Bad Sachsa' AJ517202
Glomus sp. 'Bad Sachsa' AJ517201
Glomus sp. 'Bad Sachsa' AJ517200
Glomus sp. 'Bad Sachsa' AJ416419
Glomus sp. 'Bad Sachsa' AJ517204
69
100
100
Glomus sp. 'Bad Sachsa' AJ517206
Glomus sp. 'Bad Sachsa' AJ517205
Glomus sp. 'Bad Sachsa' AJ517203
Glomus sp. 'Bad Sachsa' AJ504648
Glomus sp. 'Bad Sachsa' AJ504647
Glomus sp. 'Bad Sachsa' AJ517199
77
Saale Valley Germany
Glomus coronatum X96844
Glomus mosseae X96829

Fig. 35. Strict Consensus Tree of the Glomeromycota belonging to *Glomus* Group A (*sensu* Schüßler et al. 2001) based on 28 ITS sequences of the nrDNA. The phylogenetic position of the newly described *G. xanthium* is given in bold. Numbers above branches give bootstrap support derived from 1000 replicates. Sequences of *Glomus coronatum* and *G. mosseae* were used as outgroups.

When observed under a dissecting microscope, spores of *G. xanthium* most resemble small-spored isolates of *G. aggregatum* N.C. Schenck & Sm. emend. Koske and *G. intraradices* N.C. Schenck & S.M. Sm. These species produce yellow-colored spores that frequently occur in both aggregates tightly associated with roots and inside them (Błaszkowski 2003; Schenck & Smith 1982; Stürmer & Morton 1997).

Using a light microscope, examination of spores crushed in a mixture of PVLG and Melzer's reagent readily separates the three fungi. The spore wall of *G. xanthium* is composed of two, usually adherent rigid, semi-permanent and permanent layers, respectively, readily separating from a laminate innermost layer when crushed (Figs. 22-29). The spore wall of *G. aggregatum* and *G. intraradices* also consists of three layers, of which two outer ones usually detach from the innermost laminate layer in crushed spores (Błaszkowski 2003; Schenck & Smith 1982; Stürmer & Morton 1997). However, the two outer spore wall layers of the latter fungi are short-lived and usually are completely sloughed in mature spores (Błaszkowski 2003; Stürmer & Morton 1997). Additionally, the outermost wall layer of both *G. aggregatum* and *G. intraradices* stains red to purple in Melzer's reagent (Błaszkowski 2003; Stürmer & Morton 1997), whereas that of *G. xanthium* ramains non-reactive in this reagent. Finally, the unique character of *G. aggregatum* is the production of spores inside their parent spores by internal proliferation (Błaszkowski 2003; Koske 1985).

Although morphology placed *G. xanthium* close to *G. intraradices*, molecular data did not confirm this estimation. Unfortunately, there is lack of sequence data for *G. aggregatum*. Based on available molecular data, *G. xanthium* can be considered a member of *Glomus* Group A. While all the well known species of this group are distinct from *G. xanthium*, *Glomus* sp. 'Bad Sachsa'-sequences were found to be the closest relatives in the phylogentic analyses (Figs. 17 and 35). Firstly detected by Landwehr et al. (2002) at a gypsum slope in the southern Harz mountains (Germany), similar sequence types were found in further studies within Germany (Renker et al. 2003, Börstler et al. unpubl. data). Quite recently, Wubet et al. (2003) detected a *Glomus* sp. in Ethiopia colonizing roots of *Prunus africana*. ITS sequences of this fungus fall into the same sequence cluster like *G. xanthium* and the original *Glomus* sp. 'Bad Sachsa' sequence (Fig. 35).

Glomus aurantium and *G. xanthium* are probably adapted to warm soils of southern hemisphere. They have not been found in any of ca. 3000 soil samples collected in different dune and non-dune soils of northern Europe (Błaszkowski 2003). Koske (1987) found temperature to be the main abiotic factor influencing the structure of arbuscular fungi of the barrier dunes extending from New Jersey to Virginia. According to Pirozynski (1968), temperature is the major factor determining the distribution and occurrence of fungi in general.

Acknowledgments

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Three new taxa of *Stereocaulon* from China

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Abstract—Three taxa of the lichen genus *Stereocaulon* from China, namely *Stereocaulon intermedium* var. *gracile*, *St. kangdingense* and *St. sorediiphyllum* are described in this paper as new to science. The diagnoses in Latin and descriptions and remarks in English are given. In addition, each taxon is provided with a photograph.

Key words—*Stereocaulon intermedium* var. *gracile*, *St. kangdingense*, *St. sorediiphyllum*

During studies of the lichen genus *Stereocaulon* in China, some interesting specimens drew our attention. After an examination of them in detail three taxa are considered as new to science and described in the present paper.

1. ***Stereocaulon intermedium*** **(Savicz) H. Magn. var.** ***gracile*** **M. R. Huang & J. C. Wei,** *var. nov.* **FIGURE 1**

> *Varietas nostra a var.* intermedio *pseudopodetiis decumbentibus et apotheciis nec apicalibus et lateralibus differt.*
>
> **TYPE—CHINA. Sichuan:** E. slope of Mt. Gongga, alt. 2400 m, on sandy soil, 23.VI.1982, *Wang X. Y., Xiao X. & Li B., no. 8841* (HMAS-L, **HOLOTYPE!**).

DESCRIPTION—Primary thallus evanescent in early stage. Secondary thallus with decumbent and caespitose stalks, i.e., pseudopodetia compactly caespitose, tuft-like, decumbent, slightly dorsiventral, cylindrical, slightly twisted, not tapered, gracile, 2.5-5 cm long, 0.5-1 mm thick, moderately branched, irregular, main stems conspicuous, completely decorticated, heavily or sometimes rather thinly tomentose, felted, whitish, not ligneous, without soredia, firmly or sometimes rather loosely attached to substrate; phyllocladia numerous, grain-like to mainly terete-coralloid, 0.1-0.2 mm thick, ash-gray, with paler tips, usually not over 1 mm long, but abundantly branched in an antler-like manner. Cephalodia abundant, sessile, globose to subglobose, 0.1-0.5 (-0.8) mm in diameter, with white pruina in surface or half-immersed in tomentosa, poorly corticate, containing *Nostoc* sp.

Apothecia abundant, terminal and lateral, with pseudolecanorine margin in earlier stage, disappearing later; disc brown, flattened or slightly convex; hymenium hyaline, 40-50 μm thick, both hypothecium and central cone colorless; asci 31-47 μm × 7-10 μm; spores 8 per ascus, colorless, clavate, 3-septate, 27-37 μm × 2-3 μm.

Pycnidia not observed.

CHEMISTRY—K+ yellow, P+ pale yellow; TLC: atranorin, lobaric acid.

OTHER SELECTED SPECIMENS EXAMINED — **CHINA. Sichuan:** Mt. Emei, alt. 2800 m, on rock, 18.VIII.1963, *Zhao J. D. & Xu L. W., no. 8144*; **Wolong**, alt. 2200 m, on rock, 24.VIII.1982, *Wang X. Y., Xiao X & Li B, no. 9635*. **Yunnan: Gongshan**, alt. 3300 m, on humus, 26.VII.1982, *Su J. J., no. 2620*; **Weixi**, E. slope of Mt. Biluo, alt. 3300 m, on rock, 13.VII.1981, *Wang X. Y., Xiao X. & Su J. J., no. 4642*. **Xizang: Nyalam**, alt. 3670 m, on soil, 14.VI.1966, *Wei J. C., Chen J. B. & Zong Y. C., no. 1571*. **INDIA.** Anchal Pradesh: **Chamoli Distr.**, between Waan and Bhuna, alt. 11500 feet, on soil over rock with mosses and foliose hepatics, *A. Singh, no. 91599-1* (FH!), which was segregated from the holotype specimen of *St. paradoxum* I. M. Lamb.

REMARKS —The variety is distinguished from *St. intermedium* var. *intermedium* (FH-syntype!) mainly by lateral and terminal apothecia and decumbent, gracile and thickly tomentose pseudopodetia. It is widespread in southwestern China.

2. *Stereocaulon kangdingense* M. R. Huang & J. C. Wei, *sp. nov.* **FIGURE 2**

Species St. esterhuyseniae *similis a qua pseudopodetiis non lignosis tomentulosis et cephalodiis presentibus differt.*

TYPE — **CHINA. Sichuan: Kangding,** Shade, alt. 3300 m, on soil, 18.X.1999, *Chen L. H., no. 990108* (HMAS-L, **HOLOTYPE!**).

DESCRIPTION—Primary thallus evanescent in early stage. Pseudopodetia compactly caespitose, decumbent, obviously dorsiventral, cylindrical, 1-1.5 cm long, 0.5-1 mm thick, expanded into flattened and flabellate ends with digitately divided margins, sparsely dichotomously branched; main stems inconspicuous, completely decorticated on ventral side, covered with thin and smooth tomentosum, well corticate on dorsal side, especially the parts near the tips, not ligneous, without soredia, firmly attached to substrate; phyllocladia scarce, replaced by flabellate pseudopodetial apices or poorly differentiated cortex and adhered to pseudopodetia, crenate-lobulate. Cephalodia abundant, sessile, globose to verrucose, not over 0.5 mm in diameter, bluish, but pruinose in most cases, poorly corticate, containing *Nostoc* sp.

Apothecia and pycnidia not observed.

CHEMISTRY—K+ yellow, P+ red; TLC: atranorin, stictic acid, norstictic acid.

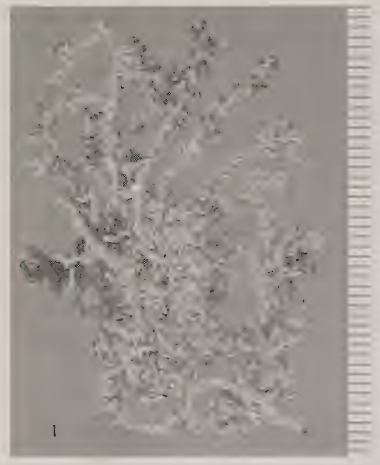
ADDITIONAL SPECIMEN EXAMINED — **Sichuan:** NW slope of Mt. Gongga, alt. 2950 m, on rock, 11.VIII.1982, *Li B., Wang X.Y. & Xiao X., no. 0374*.

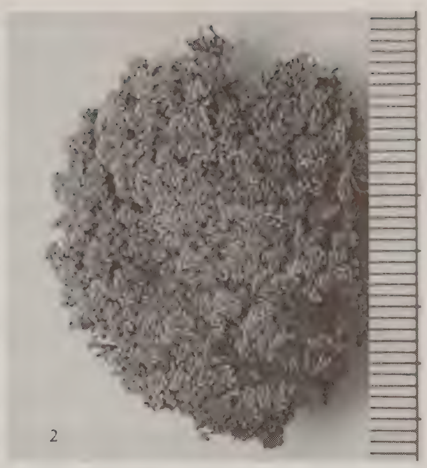
REMARKS—It seems to be very close to *St. esterhuyseniae* I. M. Lamb (CANL-holotype!). However, it can be recognized by presence of cephalodia, thin tomentum and non-ligneous pseudopodetia. What is more, the latter species is found only in South Africa so far (Lamb 1953, 1977). The resemblance of these two species suggests that they are a pair of vicarious species.

3. *Stereocaulon sorediiphyllum* M. R. Huang & J. C. Wei, *sp. nov.* **FIGURE 3**

Species St. coniophylli *similis a qua phyllocladiis granulosis et pseudopodetiorum apicibus non subfoliosis praecipue differt.*

TYPE — **CHINA. Jilin:** Mt. Changbai, alt. 1750 m, on rock, 9.IX.1997, *Guo S. Y., no. 1105* (HMAS-L, **HOLOTYPE!**).





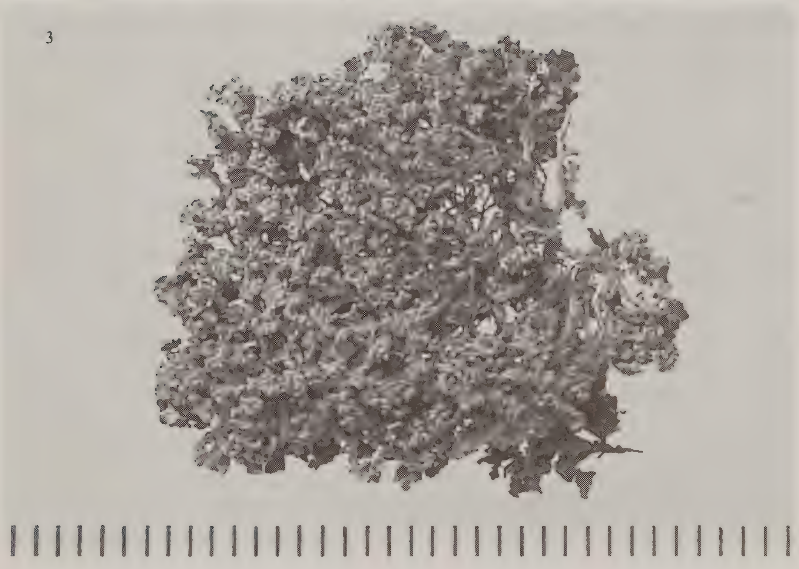


Fig. 1. *Stereocaulon intermedium* var. *gracile* (holotype). Scale=1 mm. Fig. 2. *Stereocaulon kangdingense* (holotype). Scale=1 mm. Fig. 3. *Stereocaulon servediiphyllum* (holotype). Scale=1 mm.

DESCRIPTION — Primary thallus evanescent in early stage. Pseudopodetia compactly caespitose, erect, not dorsiventral, cylindrical, dwarfish, only 0.5-1.5 cm high, ca. 1 mm in diameter, abundantly branched, mostly corymbose; main stems inconspicuous, completely decorticated, glabrous, not tomentose, yellowish, obviously ligneous, some pseudopodetial ends flattened and subfoliose and brown, corticate on upper surface, and ecorticate, completely sorediate on lower surface, like but not as much as in *St. coniophyllum* I. M. Lamb, firmly attached to substrate; phyllocladia numerous, grain-like, ca. 0.2 mm in diameter, aggregated at tips of pseudopodetia and their branchlets, but rare or absent in other parts, whitish, thinly pruinose; some phyllocladia are sorediate. Cephalodia rare, sessile, subglobose, 0.5-1.5 mm in diameter, brown, protosacculate, containing *Nostoc* sp.

Apothecia and pycnidia not observed.

CHEMISTRY—K+ yellow, P+ pale yellow. TLC: atranorin, lobaric acid.

ADDITIONAL SPECIMEN EXAMINED — SHAANXI: MT. TAIBAI, on rock, 5.VI.1963, *Wei* J. C. et al., *s.n.*

REMARKS—The new species is closely related to *St. coniophyllum,* from which it is distinguished by bearing numerous grain-like phyllocladia and by the basically nonsubfoliose apices of pseudopodetia.

Acknowledgements

The project was financially supported by the National Natural Science Foundation of China no. 30270005. The authors are very grateful to the keepers of the herbaria FH and CANL for loan of type specimens, and to Ms. H. Deng for checking some place names of China.

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Lamb, IM. 1953. New, rare or interesting lichens from the southern hemisphere II. Lilloa 26: 401-438.

Lamb, IM. 1977. A conspectus of the lichen genus *Stereocaulon* (Schreb.) Hoffm. J. Hattori Bot. Lab. 43: 191-355.

MYCOTAXON

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Book reviews and notices

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General

Cultivation and Diseases of *Proteaceae*: *Leucadendron, Leucospermum* and *Protea*. By Pedro W. Crous, Sandra Denman, Joanne E. Taylor, Lizeth Swart & Mary E. Palm. April 2004. Centraalbureau voor Schimmelcultures, P. O. Box 85167, 3508 AD Utrecht, The Netherlands. [CBS Biodiversity Series No. 2.] Pp. xii + 228, figs 460, col. plates 32. ISBN 90 70351 50 1. Price: € 60.

This is a most unusual book for one focused on diseases of cultivated plants, in that it combines authoritative information on their cultivation and harvesting for the cut-flower market with detailed taxonomic treatments of the disease-causing organisms. The diseases are divided into the categories: foliar (36); stem, shoot and flower diseases (9); root diseases (7); and those caused by bacteria and phytoplasms (2). In addition there are sections on untreated fungi and poorly understood diseases. In many cases, similar diseases are caused by different fungi on different host genera or species, for example *Batchleromyces, Botryosphaeria, Colletotrichum, Coniothyrium, Elsinoë, Mycosphaerella, Phaeophleospora, Pseudocercospora,* and *Trimmatostroma*. In such cases, keys to the species are often included. For each species treated, full nomenclatural information is presented with places of publication and synonyms, but not types (except for newly described species), symptoms are described, there is a detailed description of the fungus on the host and of its cultural characteristics, details on host range and distribution, the disease cycle and epidemiology, control, and other pertinent notes. The fungi are also illustrated by first-rate line drawings and photomicrographs, and in many cases colour photographs of the symptoms. The new genus *Saccharata* is introduced for the species currently known as *Botryosphaeria proteae* (anamorph *Fusicoccum proteae*), the new species *Coniothyrium grandicipis* is described, and one new combination made (*Pseudocladosporium proteae* for *Cladophialophora proteae*). Responsibly, some fungi treated are not referred to species belong to genera which are regarded as currently 'in disarray', for example *Pestalotiopsis* sp. There is an extensive bibliography, and also both general and host indices. The book is sure to become the key reference work commercial growers will want to hand, as well as mycologists wishing to identify fungi on plants from this family. Though its level of treatment from the host cultivation, pathological, and fungal taxonomic viewpoints, the book also sets a new 'gold standard' for future texts on the fungi causing diseases of particular crop plants.

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[1] Books for consideration for coverage in this column should be mailed to the Book Review Editor (address above) in the first instance. Fax (+34) 91 857 3640; e-mail: myconova@terra.es.

Journal of Fungal Research. Editor in Chief Yu Li. 2003 on. Journal of Fungal Research, Jilin Agricultural University, Changchun, Jilin 130118, People's Republic of China. Quarterly. ISSN 1672-3538. Price: US $ 60 p.a.

This new journal is launched in the introduction to the first part by Jiang-chun Wei as 'a window for academic exchange concerning the science, technology and education of pan [*sic*!] fungi'. The first issue (December 2003), which includes an intriguing article by David N. Pegler on 'The fly agaric, soma, Father Christmas and the Vikings', includes 13 research articles, the topics of which range from molecular systematics, to bioactive compounds, diversity, and new records for provinces of China. The second issue (March 2004) has eight papers, including an annotated checklist of *Tricholoma* species in China. Both parts also include 2-4 reviews in Chinese, listed under the heading 'Summary', and covering topics from 'simple and easy DNA preparation' to triterpene constituents of *Ganoderma*. Papers are either in English or Chinese, with abstracts in both languages. The journal has a broader scope than *Mycosystema* (now incorporating *Acta Mycologica Sinica*), and with so much mycological activity going in China today this new journal will provide a much-needed further outlet for that research. It is clearly a title to which all major mycological libraries should subscribe.

Recent Research Developments in Mycology. Managing editor S. G. Pandalai. 2003 on. Transworld Research Network, T.C. 37/661(2), Fort P. O., Trivandrum 695 023, Kerala, India. Pp. 85. ISBN 81 7895 117 7. Price: Not indicated.

There is unquestionably a need for more authoritative review articles in mycology. This aim is implicit in the title of this new series, although no explanation of its objectives appears in the first issue. The first number includes six articles which are diverse in scope. These address hyphal tip growth in *Achlya bisexualis,* blackspot disease of roses, fungal lectins and their roles, commercial applications of *Trichoderma* cellulases, knowledge of Spanish fungi, and white blister rust of pine. While it is evident that the title will be one that should be held by major mycological libraries, just how relevant it will be to systematic mycologists will depend on the topics of articles and the calibre of authors it attracts.

Basidiomycetes

Cytology and Plectology of the *Hymenomycetes*. By Heinz Clémençon (assisted by Valerie Emmett & Ernest E. Emmett). May 2004. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, D-14129 Berlin, Germany. [Distributor: E. Schweizerbart'sche Verlagsbuchhandlung, Johannesstraße 3A, D-70176 Stuttgart, Germany.] [Bibliotheca Mycologica No. 199.] Pp. viii + 488, tables 12, figs 632. ISBN 3 443 59101 9. Price € 96.

Although not a taxonomic work *per se*, this remarkably detailed treatment of the cellular and subcellular structures and tissues in the *Hymenomycetes* is sure to become recognized as the key reference work mycologists will wish to have to hand when describing and comparing structural features of macrofungi. Heinz Clémençon published his monumental *Anatomie der Hymenomyceten* in 1997 (Clémençon 1997), but in his Foreword to the new book explains his disappointment at colleagues who requested review copies of that work but never published reviews[2]. He records that another mycologist published 'a rather unpleasant and often unsubstantiated criticism' in *Sydowia,* and that he vowed never to publish a second edition or to translate it into English. Fortunately for mycology, his views were changed by later reviews in other journals (also by mycologists who had not requested free copies), and meeting up with Ernest and Val Emmett in 2000 who agreed to help with the English of a new work; he then 'decided to start writing'. But he also kept his vow; this is not a new edition nor a translation, but a new and substantially shorter book (488 *vs* 996 pages) incorporating data from many new microscopic preparations.

The contents are divided into sections on: Hyphae; the Mycelium; Mitospores; Basidia and basidiospores; Cystidia, pseudocystidia and hyphidia; Pigment topography; Bulbils, sclerotia and pseudosclerotia; Basidiomes; Carpogenesis; and Associations with other organisms. The emphasis is on describing, illustrating, and giving unambiguous names to the structures found. Because of the fine degrees of precision adopted, the numbers of specialized and generally rather unfamiliar terms employed is somewhat daunting. I wonder how many mycologists would know immediately what the following terms referred to: physalohyphae, acrophysalides, hydroplera, malocysts, coriotunica, blastokysts, lipsanoblema, or podostratum? Most of the terms used have been coined before by other mycologists, but have not entered general use. The choice of terms is discussed, and in some cases lists of ones to be avoided or which he has rejected are provided; these categories are especially large in relation to terms used to describe types of cystidia.

The line drawings, electron micrographs and photomicrographs are all superb and clearly have been lovingly executed, although some are reduced to a rather small size.

The chapter on associations with other organisms may at first seem rather out of place, but here the emphasis is on the special structures involved in interactions. Those treated range from bacteria and algae to trees and invertebrates. I found the photographs and drawings of "termitospheres" especially interesting, and I can imagine the updated diagram and key to mycorrhizal types on p. 421 being rapidly incorporated into mycology lectures and used as hand-outs all over the world.

I am sure that the 1997 book did not receive the accolade and circulation it merited primarily because of the length and the language used. The decision to prepare a book of under half the length of the earlier one and also to present it in English will mean that it is perceived and used internationally. The decision to have Valerie and Ernest Emmett assist with the English style was a wise one and their imprint is evident on almost every page. "Val" and "Ern", the first a former schoolteacher and assessor and the latter one of the foremost field mycologists in Europe, have made sure that the language is lucid and unambiguous almost throughout. Reading between the lines of the Foreword, it is evident that they also repeatedly questioned particular choices and definitions. They have much to be proud of in making the contents as accessible as possible to mycologists in general.

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[2] As compiler of the Book Reviews and Notices section for *Mycotaxon,* I have too frequently had the experience of mycologists agreeing to review titles for the journal, but then either never, or belatedly after several reminders, submiting their reviews. Sadly this has meant that a few titles received by *Mycotaxon* have still not been featured in the journal 2-4 years after the books were received from the publishers.

This is sure to become a mycological classic, and deserves to be on the mycological best-seller list. All who work with hymenomycete fungi will need this work to hand, especially as increasing numbers of mycologists take up the recommended terms, and further as many are not defined or nor illustrated in the current edition of *Ainsworth & Bisby's Dictionary of the Fungi* (Kirk *et al.* 2001).

I trust Heinz Clémençon will find at least this review acceptable, and expect the sentiments to be echoed in others yet to appear.

Clémençon, H. (1997) *Anatomie der Hymenomyceten*. Teufen: F. Flück-Wirth.

Kirk. P. M., Cannon, P. F., David, J. C. & Stalpers, J. A. (2001) *Ainsworth & Bisby's Dictionary of the Fungi*. 9th edn. Wallingford: CAB International.

Fungi of Australia. Volume 2B. Catalogue and Bibliography of Australian Fungi 2. *Basidiomycota* p.p. & *Myxomycota* p.p. By Tom W. May, J. Milne, S. Shingles & R. H. Jones. 2003. Australian Biological Resources Study and CSIRO, CSIRO Publishing, P. O. Box 1139, 150 Oxford Street, Collingwood, Victoria 3066, Australia. Pp. 452, coloured plates 64. ISBN 0 643 06907 0. Price: AS $ 99.

The fine series *Fungi of Australia* is a valuable contribution towards our knowledge of mycology in the region, intending to cover in sixty volumes the great diversity of fungi present in this country. Two volumes have been published to date, both separated into two parts. Volume 1A where John Walker's classification of fungi provides a pragmatic framework at the higher levels (Walker 1996), and which also includes a key to the orders following mainly the concepts outlined in the 7th edition of *Ainsworth & Bisby's Dictionary of the Fungi*, and Volume 1B, both published in 1996 (reviewed in *Mycotaxon* **62**: 492-493, 1997). Volume 2 intends to provide a basic bibliographic tool to facilitate the preparation of taxonomic treatments of Australian fungi, and is designed as well for anyone wishing to use up-to-date names of Australian fungi. Volume 2A covered several orders of agarics, boletes and hypogeous fungi, and was reviewed in *Mycotaxon* **66**: 515-516 (1998). Volume 2B aims to include the remaining genera of six of the orders of larger *Basidiomycota* already dealt with in volume 2A, along with all Australian representatives of a further 19 orders in the *Basidiomycota*, as well as nine orders of the larger *Mycomycota*. In Volume 2B the orders follow the system used in the 8th edition of *Ainsworth & Bisby's Dictionary of the Fungi,* with the exception of *Ceratiomyxales*, which is kept separate from *Protosteliales*. Other parts of the *Fungi of Australia* which will cover the remaining groups of fungi are in preparation. Both parts of Volume 2 provide full bibliographic citations of all names applied to taxa recorded from Australia, list the taxa according to their accepted names, provide a list of synonyms, and compile the relevant literature and pertinent literature records for each accepted name.

Unusually for a checklist, 64 species are illustrated with good quality colour photographs. Any mycologist working in the rich tropical Southern Hemisphere regions wishing to make comparisons between the mycobiotas of different countries or regions will find this book extremely useful and a "must" for reference. The bibliography section comprises approximately 37 pages of references in 8 pt type, which facilitate access to specialized mycological publications. The conventions used in the citation of literature, abbreviations and contractions are provided as well, the layouit is conveniently explained on the inside fron cover and fly leaf, and the whole is fully indexed.

This book will be useful to both amateurs and professionals who are interested in knowing more about the diverse fungi of this region, as well as those who will work on monographs for later volumes in the series. As there are so few concise guides to the fungi of Australia, this new book is so much more valuable and is sure to be used more extensively than is usual for national catalogues and checklists.

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Taxonomy, Ecology and Distribution of *Hygrocybe* (Fr.) P. Kumm. and *Camarophyllopsis* Henrink (*Fungi, Basidiomycota, Hygrocybeae*) in Greenland. By Torbjørn Borgen & Eef Arnolds. 2004. Danish Polar Centre, Strandgade 100H, DK-1401 Coppenhagen, Denmark. [Meddelelser om Grønland, Bioscience No. 54.] Pp. 68, figs 24. ISBN 87 90369 68 8. Price: DKK 200 .

This is a regional monographic treatment of *Hygrocybe s. lat.* and *Camarophyllopsis* in Greenland. A key and descriptions are provided to 26 species and five varieties. Two taxa are described as new: *Hygrocybe rubrolamellata* sp. nov. and *H. conica* var. *aurantiolutea* var. nov. The descriptions are detailed, informative, and well formatted for locating information. The figures are especially noteworthy, and often include superb drawings of the hymenophoral trama or the pileipellis, critical elements in the taxonomy of this group. Plots of spore widths *versus* lengths and variation in size of the pileipellis terminal elements are also provided. The authors propose that the size of the elements in the stipititrama of *Hygrocybe* subsection *Squamulosae* is of taxonomic value, and have presented the data necessary to negate the possibility that this character varies with habitat. The taxonomy is accurate except for what appears to be one misapplied name, *H. cantharellus*. The lamellar trama hyphae of the specimens from Greenland are larger than those from specimens taken near the type locality of *H. cantharellus* in North Carolina, USA (49–194 x 4.5–25.5 *vs* 5.6–44 x 4–16) μm). In addition, the aspect of the basidiomes differs between the European concept used by the authors and the original (the stipe length is generally less than twice the pileus diameter in Europe and Greenland, *vs* 2–4 times longer than the pileus diameter in the Americas). One table showing the distribution of the 30 taxa among the various habitats, and another showing the timing of fruiting for 11 of the more common taxa augment the introductory material and the discussion of ecology. The high quality and detail of the descriptions and supporting line drawings and graphs will make this book appealing to agaricologists working in the North Temperate and boreal zones.

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Ascomycetes

***Laboulbeniales* II. *Acompsomyces – Ilyomyces*.** By Sergio Santamaria. November 2003. J. Cramer in Gebrüder Borntraeger Verlagsbuchhandlung, Berlin. [Distributor: E. Schweizerbart'sche Verlagsbuchhandlung (Nägele u. Obermiller), Johannestraße 3A, D-70176 Stuttgart, Germany.] [Flora Mycologica Iberica Vol. 5.] Pp. 344, figs 93. ISBN 3 443 65010 4. Price: € 78.

This contribution, the fifth volume of an ongoing series on Iberian fungi, represents the second volume devoted to members of the *Laboulbeniales*. An earlier issue (Santamaria 1998) dealt only with the large genus *Laboulbenia*. This volume treats 40 additional genera and 106 species, all arranged alphabetically, beginning with *Acompsomyces* and ending with *Ilyomyces*. A third contribution on *Laboulbeniales* is planned to treat the remaining known taxa between *Misgomyces* and *Zodiomyces*.

The current volume more or less mirrors the format of Santamaria (1998) with generic circumscriptions followed by the author's observations, a key to the known Iberian representatives, and detailed descriptions and illustrations of each of these. One improvement over the previous volume is the inclusion of copious illustrations of all species, including, where possible, line drawings of thalli at different stages of development. Many of these drawings are excellent and emphasize key features of note for each taxon.

Descriptions of genera and species are, on the whole, well written yet succinct – although no mention is made of the numbers of thalli studied for each taxon, and therefore, in some cases (e.g. *Acompsomyces brunneolus* and *A. corticariae*) it is difficult to reach conclusions on the utility of particular morphological characters, and indeed on the validity of different taxa. It is also unfortunate that the author did not attempt to re-examine type material in cases of dispute over the status of some "species" (e.g. *Camptomyces europaeus, C. melanopus*).

Despite the above, there is no doubt that this work will be an essential reference for anyone studying *Laboulbeniales*, particularly the European taxa. The quality of the descriptions and illustrations should accommodate those with even a rudimentary knowledge of *Laboulbeniales*. In this regard I am hopeful that a key to the genera will be included in the remaining Part, as this will be critical in attracting new students. The author is to be commended on the level of detail and scholarship contained within this volume.

Santamaria, S. (1998) *Laboulbeniales I. Laboulbenia*. [Flora Mycologica Iberica Vol. 4.] Madrid: Real Jardín Botánico.

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***Hyaloscyphaceae*, *Sarcoscyphaceae* et *Sarcosomataceae*.** By Wen-Ying Zhuang, Zhi-He Yu & Zheng Wang. 2004. Science Press, 16 Dong-Huang-Cheng-Gen-Bei Street, Beijing 100717, People's Republic of China. [Flora Fungorum Sinicorum Vol. 21.] Pp. 192, figs 66, plates 36. ISBN 7 03 012618 1. Price: US $ 35.

The *Flora Fungorum Sinicorum* is one of five series of monographs produced as a part of the Cryptogamic Flora of China initiative of the Chinese Academy of Sciences.

The project formally started in 1973, and the first fungal volume was published in 1987; this new work represents the 14th to have appeared to date, and the second on discomycete families; Wen-Ying Zhuang prepared one covering the *Geoglossaceae* and *Sclerotiniaceae* in 1998 (vol. 8), and in this new volume she is the author or co-author of all 34 generic accounts included, in total covering 141 species. The largest family covered is the *Hyaloscyphaceae* with 18 genera and 99 species. Keys to the genera in each family and to the species within each genus are provided. The species accounts include full bibliographic citations to both accepted names and synonyms, detailed descriptions, information on hosts and distribution (often by citation of specimens in HMAS), and in many cases clear line drawings of microscopic features. The drawings of excipular tissues are especially carefully made; these structures are not figured in many regional works so this aspect will prove of particular value. The plates comprise half-tone photographs of microsocopic features and scanning electron micrographs of ascospores in selected species, and one in colour showing the macroscopic appearance of four species. Great care clearly went into preparing the original half-tone plates, but the unfortunate quality of the printing limits the amount of information that can be gleaned from them. Habit drawings and photographs are generally absent, which, although not critical, would have been an additional help to those trying to determine species in genera such as *Lachnum*.

No new scientific names appear to be introduced, the authors having previously described new species they have found in primary journals, especially *Mycotaxon*. This is a taxonomic practice commended by many plant systematists as in general journals have wider circulations than books and are therefore more accessible to researchers. Nevertheless, there is clearly yet more work needed on some of the species treated, five having “cf.” inserted before the species name. The authors clearly recognize that publication of such synthetic works should not be delayed until all problems are resolved. The aim of treatments like this should be to provide an authoritative synthesis of the current state of knowledge, a foundation on which future researchers can build.

In general the nomenclature appears to have been carefully checked and follows the current *Code*, though I did catch “(Pat. in Duss)” on p. 73 (three times) in author citations where this should have been just “(Pat.)”, although the information was correctly presented where the basionym was cited. I also found the placement of indications of sanctioned status before the original place of publication of the name somewhat confusing as the unwary may think that the reference refers to where the name was sanctioned.

Wen-Ying Zhuang is already to me the doyenne of Chinese discomycetes. This new book not only confirms her in that position, but demonstrates that we can expect much more from her now that she has shed some of her formerly demanding administrative tasks in Beijing.

Lichen-forming Fungi

Le genre *Strigula* (Lichens) en Europe et en Macaronésie. By Claude Roux & Emmanuel Sérusiaux (in collaboration with Olivier Bricaud & Brian J. Coppins). July 2004. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung,

D-14129 Berlin, Germany. [Distributor: E. Schweizerbart'sche Verlagsbuchhandlung, Johannesstraße 3A, D-70176 Stuttgart, Germany.] [Bibliotheca Lichenologica No. 90.] Pp. 96, figs 39, tables 2. ISBN 3 443 58069 6. Price: € 32.00.

The lichen genus *Strigula* is best known as an abundant and conspicuous element of the foliicolous lichen biota in the (sub)tropics. The species on other substrates and especially those growing (also) outside the tropics are less conspicuous and in general poorly known. A critical study of these species is therefore very welcome, even though most species are only rarely encountered. In practice, they should be looked for in the same microhabitats where *Porina* species are occurring, *viz.* sheltered smooth bark and shaded rock (and of course living leaves, in Europe usually *Buxus*). Species of *Strigula* are undoubtedly sometimes confused with *Porina* species, and the differentiating characters are rather subtle (ascus tip, hamathecium branching) and often difficult to observe. The exception is when macroconidia are being produced, which invariably have typical gelatinous appendages, obvious only when observed with a good microscope. Specimens with only macroconidia have in the past been described sometimes as separate taxa under the illegitimate generic designation *Discosiella*, to which no reference is made in the book.

This revision gives identification keys in English, French and Esperanto to all species in Europe and Macaronesia, and full descriptions of all species in French, with an enumeration of (selected) specimens. Details of all species are illustrated with line drawings. There are separate keys for specimens with (only) macroconidia. Reminiscent species of *Porina* are not included or mentioned in the text.

The book contains much novel information, including six species new to science, one new combination, and three new synonymies. The common corticolous pantropical *S. phaea* is reported from Europe, while the European specimens earlier assigned to the common foliicolous pantropical *S. smaragdula* are shown to belong to a new species. A full description of *S. smaragdula* is given though for comparison. The specimen lists contain many new records for various countries, especially in Western Europe.

The species concept is still a bit unsettling especially in the *S. calcarea*-group. Specimens producing macroconidia only (and no ascomata) are rather frequent, and in fact from two of the species newly described here no ascomata are known at all, whereas from the two other species in the group no macroconidia are known, but only ascomata. This group includes the only terricolous species in the genus, *S. sychnogonoides*, which is still often classified in a separate genus, *Geisleria*, mostly because there is no overwhelming evidence (macroconidia, DNA analyses) that it fits into *Strigula*. It is also still known under the name *Porina glaucocinerea*, to which surprisingly no reference is made in the text. Especially, the broadly fusiform ascospore shape is deviant from the remaining species of *Strigula*, with the exception of the newly described *G. thelopsidoides*, which might in future turn out to be a second species of *Geisleria*.

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The Netherlands.

Ascomycetes Lichenisati: Species foliosae et fruticulosae. [Lapiškosios ir krūmiškosios kerpės.] By Jurga Motiejūnaitė. 2002. Valstiečių Laikraštis, Botanikas Institutas, Žaliujų ežerų 49, LT-08406 Vilnius 21, Lithuania. [Mycota Lithuaniae/Lietuvos Grybai Vol. 13(1).] Pp. 312, figs 90, coloured plates 8. ISBN 9986 847 52 4. Price: € 28.

This is the first major work on Lithuanian lichens to have appeared since the checklist of Minkevičius (1963). Following a history of the study of lichens in the country and general accounts of lichens and their biology and ecology, treatments of 189 macrolichen species are presented, of which 16 have not been seen for 50 years or more and 50 are included in the Red Data Book of Lithuania. Keys to genera, and to species within genera are provdied. For each species treated, full bibliographic nomenclatural information is provided, along with descriptions, notes on ecology and distribution, and in many cases distribution maps. The colour plates are of a selection of 30 species. The work is in Lithuanian with a summary in English. I was especially pleased to see this volume included in the *Mycota Lithuaniae* series, as some countries still find it hard to accept that lichen names are those of the fungal component and that their place is thus in fungal rather than botanical series. This will be a major stimulus to the study of lichens in Lithuania, and the author is to be congratulated on producing this detailed synthesis and placing our knowledge of the country's macrolichens on a par with that of many others in Europe.

Minkevičius, A. (1963) Medžiaga lietuvos TSR kerpių florai. *Biologija* (Vilnius) **3**: 79-95.

Contributions to Lichenology: Festschrift in Honour of Hannes Hertel. Edited by Peter Döbbeler & Gerhard Rambold. 2004. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, D-14129 Berlin, Germany. [Distributor: E. Schweizerbart'sche Verlagsbuchhandlung, Johannesstrasse 3A, D-70176, Stuttgart, Germany.] [Bibliotheca Lichenologica No. 88.] Pp. vii + 739, figs 181, tables 28. ISBN 3 443 58067 X. Price: € 148.

This Festschrift contains 44 papers by 79 authors from 19 countries. The papers in it were brought together discretely in 2003, and presented as a surprise gift to Hannes Hertel on the occasion of his 65th birthday. A table of contents is available on http://www.schweizerbart.de/pubs/books/bo/bibliothec-05008800-desc.html and maybe one should look at this webpage while browsing through this review in *Mycotaxon.*

Reading through the titles one can see 19 single author contributions, and 13 papers generated by dual author teams, indicating that lichenology is still a subject where substantial contributions can be made by individuals under the restrictions of research on a low budget. For a cross section of lichenology in 2003, this is well worth collecting for the bookshelf even though the price is severe.

There are a number of articles which will be of considerable long term value as references; that of Dagmar Triebel and colleagues on "IndExs–Index of Exsiccatae" is an excellent account of this topic. An herbarium curator's reaction to this paper should be to set up an e-mail co-operative to computerise all *schedae*. Mikhail Andreev's *Miriquidica* account is a must for Northern Hemisphere mountain lichen hunters, and for adventurers in the palaeotropics Harrie Sipman's *Lobaria* paper will be helpful. Floristic works of interest include Edit Farkas on foliicolous lichens from South

Africa, Klaus Kalb on mostly South American lichens, Robert Lücking on foliicolous *Porinaceae*, and Walter Obermayer on Himalayan lichens. All these floristic studies indicate the literature resources one needs to conduct practical lichen identification. One piece of taxonomic humour will be useful for teachers of lichen courses in universities; Ulrich Søchting and co-workers describe a new parasitic species *Caloplaca sauronii* named after the character Sauron in Tolkein's *Lord of the Rings* from a remote part of Antarctica. Thorsten Lumbsch's argument on homoplasy in phylogenetic analyses is essential reading for monographers in training. Overall, this is a finely produced issue that I am sure Hannes Hertel is very pleased with.

The publishers have made available what would normally be written as the proceedings of a conference, or printed as a special issue in a regular journal of an international learned society or instition. With *Bibliotheca Lichenologica* there is always variation in size, frequency of appearance, relevance to one's own interest and price. I imagine that quite a number of members of the lichenological community pick and choose volumes of *Bibliotheca Lichenologica* for their personal libraries, while institutions with lichenologists on their staff have to struggle for budgets to ensure that a full run of *Bibliotheca Lichenologica* is secured. Instead of clamouring again and again for new money issue by issue, or having to decide whether to pick an issue or not, perhaps a personal annual subscription to the series of say € 100 to cover all numbers produced in the year could be considered. Such a setup might also help to subsidise the cost of publishing *Bibliotheca Lichenologica*. This would also ensure that there are at least a few hundred copies even of the most "unpopular" numbers in the series floating about in the libraries of lichenologists. Lichenology is still a small enough subject for students to collect monographs in print to empower themselves to make identifications. With more copies of *Bibliotheca Lichenologica* in circulation in various countries, more will also become available on the second hand market in due course. After all, isolated students need to consult particular volumes to gain access to the writings of inspirational lichenologists!

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A Second Checklist of the Lichens of Italy with a thesaurus of synonyms. By Pier Luigi Nimis & Stefano Martellos. 2003. Museo Regionale di Scienze Nagturali, Saint-Pierre, Valle d'Aosta, Aosta, Italy. [Monografie No. 4; OPTIMA Commission for Lichens Publ. No. 5.] Pp. 192. ISBN not indicated. Price: € 40.

The first critical checklist of Italian lichens since the earliest decades of the twentieth century was prepared by Nimis (1993). This work, presented in English, provides a new checklist in which 2345 infrageneric taxa (i.e. species, subspecies, and varieties), 2244 of which are lichenized and accepted. These figures represent a net increase of 200 species (9.3 %) on the number accepted in 1993. On a regional level, the largest rise has been the number of species known in Umbria, from a modest 47 to 455 species; the richest region is Trento-A.Ad. with 1301 species. The introductory parts also include references to other checklists produced worldwide in recent years and explain both the philosophy adopted and nomenclatural terms, the latter with examples that will be most helpful to the non-taxonomist. The nomenclature follows most recent taxonomic changes, though with the benefit of hindsight it might have been better to adopt fewer of the parmelioid generic names as more recent molecular data shows that several have to be combined.

The accepted names are listed alphabetically, genus by genus, with author citations but not dates of publication of the accepted names. I suspect that these will be included in the new critical checklist for Italy promised for 2006. However, the main purpose of this publication is to make available the index to synonyms. This includes a staggering 12 600 infrageneric epithets listed alphabetically (with the original generic name in parenthesis) and cross-indexed to the accepted taxa. The total of number of names treated in the book, i.e. accepted epithets and synonyms, is 15 053. Further, the list of synonyms also includes ones used in other parts of southern and eastern Europe and even North Africa. The authors modestly state "this could be of some help in facilitating connections among distributed databases . . . " (p. 5). I am sure it will be, but its importance is more than regional. Indeed, I believe it must be the most extensive list of synonyms used for lichenized fungi to have been published anywhere since the compilation of Zahlbruckner (1921-40).

Only 108 names are listed as "poorly known taxa" or "dubious records"; to have such a modest number of names in these categories represents an enormous achievement in determining the applications of thousands of other names.

This will be of immense value not only in facilitating communication between databases, but to all endeavouring to interpret earlier literature; for example, when compiling local to regional or national checklists, curating herbarium specimens, or trying to interpret earlier ecological and floristic studies. It would be tremendous if this information could be combined with the names already in the *Index Fungorum* database already freely available on the worldwide web (http://www.indexfungorum.org/Names/NAMES.AS) and incorporated into the on-line global lichen checklist started by Tasilo Feuerer (http://www.biologie.uni-hamburg.de/checklists/world_1 /htm); it is already available electronically through ITALIC, the online updated version of Nimis (1993); http://dbiodbs.univ.trieste.it).

The thesaurus dimension makes this book a "must" for all working regularly with names of lichenized fungi, and at such a modest price for both personal and institutional lichenological libraries. Try and secure a copy before the print-run is exhausted!

Nimis, P. L. (1993)*The Lichens of Italy: An annotated catalogue.* [Monografia No. 12.] Turin: Museo Regionale di Scienze Naturali.

Zahlbruckner, A. (1920-40) *Catalogus Lichenum Universalis.* 10 vols. Leipzig: Borntraeger.

Keys to the Lichens of Italy. Vol. 1. Terricolous Species. By Pier Luigi Nimis & Stefano Martellos. 2004. Edizioni Goliardiche, Via SS. Martiri 18, I-34124 Trieste, Italy. [Le Guide di Dryades 1, Serie Licheni I (L-1).] Pp. 341. ISBN 88 88171 73 8. Price: € 45.

Until I saw this work, I would never have guessed that 439 lichen species occurred in terricolous habitats in Italy. But there are problems over the interpretation of this somewhat confusing and often ambiguous term, discussed in detail here. However, in the final analysis the authors adopted a broad and pragmatic view embracing lichens found on the ground regardless of whether they were directly on soils, dead bryophytes, small dead plants, or weathered rocks. The introduction also includes a "largely incomplete" synopsis of the soil-lichen communities represented which have been given formal names (e.g. *Cladonietum foliaceae* Klem. 1955), guides to users, and explanation of the orders in which characters are used and treated in the keys and descriptions. The characters in the keys are ranked according to the price of equipment needed to study them: progressively passing from bare eyes, through hand lens, chemicals, cheap microscope, UV-lamp, and professional microscope, to chromatography. This move will be applauded by the numerous non-specialists who are sure to use the book and merits emulation.

The keys themselves have been produced using the program FRIDA, which was written by the second author. They are strictly dichotomous and five in number, each dealing with species with a different growth form (i.e. fruticose, foliose, squamulose, crustose, and leprose). Where species key out, a distribution map and full small-type description is provided, along with notes on the ecology, chemicals produced, distribution and sometimes other observations. In order to facilitate the use of the book by non-specialists, a series of more manageable "simplified keys" is provided. Four separate simplified keys consider species on: subalpine-alpine, on acid to subacid substrata; subalpine-alpine, on subneutral to basic (calcareous) substrata; Mediterranean to montane, on acid to subacidic substrata; and Mediterranean to montane, on subneutral to basic (calcareous) substrata. Within each of these categories, subkeys proceed growth-form by growth-form, and there is a glossary dealing even with the most basic terms (e.g. mycelium), again to encourage amateur use. It would have been good to have some lichen illustrations, particularly colour photographs as many of these lichens are brightly coloured and strikingly attractive, but that would inevitably have impacted on the cost.

The habitat focus is an eminently practical one for stand-alone identification aids, but is rarely adopted, although a useful guide to lichens on arid soils in Australia was provided by Eldridge & Tozer (1997), a work I was surprised not to see cited in the otherwise most helpful bibliography. As many of the species have very wide distributions and the text is entirely in English, the book should do much to stimulate surveys and ecological assessments of soil crusts worldwide – hopefully particularly in arid areas where the ecosystem is fragile but so important in stabilizing soil surfaces. All who enjoy lying on their stomachs with a hand lens searching for minute black or even yellowish green ascomata at last have a *vademecum*.

Eldridge, D. & Tozer, M. E. (1997) *A Practical Guide to Soil Lichens and Bryophytes of Australia's Dry Country*. Sydney: Department of Land and Water Conservation.

Eesti Pisisamblikud. Edited by Tiina Randlane & Andres Saag. 2004. Tartu Ülikooli Botaanika ja Ökoloogia Instituudis, Tartu, Estonia. Pp. 584, figs 17, col. figs 84. ISBN 9985 56 916 4. Price: EEK 300.

A comprehensive guide to the macrolichens of Estonia was prepared by Trass & Randlane (1994). That work covered about 300 species, and this new book, also in Estonian, is essentially a companion volume. This was a most ambitious undertaking for two people, and seven additional authors were recruited to prepare the accounts of one or more genera (each of which is attributed to particular authors). It covers not only 647 species of crustose lichens, but further around 100 species of lichenicolous fungi (mainly through contributions by Ave Suija).

Introductory chapters address the nature of lichens, terminology, collection and preservation, lichenicolous fungi (with a Table detailing species occurring on different hosts), chemical reagent tests, TLC characteristics of different lichen extrolites, a systematic arrangement of genera by subclass, order and family, and a glossary illustrated by line drawings. Keys to the lichenicolous genera, sterile crustose lichens, and lichenized genera. The genera are treated alphabetically, with generic descriptions, references to key literature, keys to species, descriptions, separate diagnoses, information on ecology and distribution, and Estonian common names. The colour plates are the only illustrations provided of particular species, but are of a superb quality (and include a few lichenicolous fungi).

This work makes Estonia the only county apart from Sweden (Foucard 2001; see *Mycotaxon* **90**(1): 233-234, 2004) to have keys and descriptions to both its crustose and lichenicolous species between the same covers. An interesting new trend may be emerging, although the Estonian book was surely influenced by the Swedish one (which is cited). However, unlike Foucard's book, all lichenicolous species known in the country are treated, not just those occurring on crustose lichens.

A major achievement for Estonian lichenologists, and a book that all concerned with the distribution of crustose lichens and lichenicolous fungi will need to familiar with.

Foucard, T. (2001) *Svenska Skorplavar och Svampar som växter på dem.* Stockholm: Interpublishing.

Trass, H. & Randlane, T. (1994) *Eesti Suursamblikud.* Tartu: Tartu Ülikooli Botaanika ja Ökoloogia Instituudis.

Väike Sammalde ja Samblike Raamat. By Aino Kalda & Tiina Randlane [with photographs by Taimi Paal & Andres Saag]. 2004. AS Bit, Pikk 68, Tallin 10133, Estonia. Pp. 224. ISBN 9985 2 0926 5. Price: EEK 175.

An introductory guide to the bryophytes and lichens of Estonia. There are 53 lichens treated with superb colour photograph opposite a full page of information about the selected species. While most are macrolichens, it was good to see 17 crustose and squamulose treated. Estonian common names are provided, a box contains diagnostic features, and there is extensive information on ecology and distribution. The author and photographer of the lichen treatments (Tiina Randlane and Andres Saag respectively; *see above*) are leading lichenologists in Estonia, and the work is consequently authoritative. The existence of such a text in the country's language is sure to help encourage the interest of amateurs and students in lichenology and provides a bridge to the more detailed works on the nation's lichens now available (*see above*). However, if lichens had to be twinned with some other organisms, I would have preferred it to be non-lichenized fungi rather than bryophytes; that single act would have given an immediate positive message about their nature.

Checklist of lichens of the Western Carpathians. By Urszula Bielczyk, Anna Lackovičoká, Edit E. Farkas, László Lökös, Jiří Liška, Othmar Breuss & Sergey Y. Kondratyuk. 2004. W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland. [Biodiversity of the Carpathians Vol. 1.] Pp. 181, figs 3. ISBN 83 89648 12 1. Price: 30.

The Lichens and allied Fungi of the Polish Carpathians: An annotated checklist. Edited by Urszula Bielczyk. 2003. W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland. [Biodiversity of the Polish Carpathians Vol. 1.] Pp. 342, figs 4. ISBN 83 85444 28 9. Price: € 20.

The Carpathian Mountains are an impressive range running in an enormous 1300 km long swathe 100-300 km wide, rising to around 2300 m, and taking in parts of Austria (0.3 % of the range), the Czech Republic (3.2 %), Hungary (4.3 %), Poland (9.3 %), Romania (55 %), Slovakia (17.1 %), and Ukraine (10.3 %). To pull the diverse information and literature on the lichens in the range together has been a major international effort, which in his Foreword to the series Zbigniew Mirek hopes "marks the beginning of a new period in scientific collaboration". Following a short introduction, highlighting the changes in vegetation types with altitude and 107 geomorphological units, the alphabetical listing starts. This covers 1817 species belonging to 288 genera, with synonyms listed below accepted names and also cross-referenced to those from their positions in the alphabetical series. The countries from which each species is recorded are indicated by abbreviated country codes justified to the right-hand side of the pages. There is, however, no information on habitat, frequency, or the dates of records. When I visited the Ukraine sector in 1991, I was struck by both the lichenological richness of some areas, but also the extent to which some of the forests had been disturbed. It would have been of interest to know more of the distribution, frequency, and status of some of the old-forest indicator species in particular.

With some of the leading lichenologists in the pertinent countries involved in the compilation, the taxonomy is in generally up-to-date, with many of the more recent taxonomic changes adopted. However, there are a few nomenclatural quibbles, such as the superfluous citation of authors' names after species epithets in the names of infraspecific taxa other than that including the type, and the retention of "em." in some citations. Lichenicolous fungi are not included in the overall checklist, although some "allied" fungi are. Amongst the latter I was surprised to see the name *Tromera resinae* accepted in that genus and not in *Sarea,* which was adopted for *S. difformis* here.

The treatment on the lichens of the Polish section is much more detailed. Although constituting only 9.3 % of the range, the list accepts a staggering 1327 species, 75 % of all lichens known in the whole of Poland and 73 % of all lichens recorded in the entire Carpathian Mountains. Lichenicolous species are also included, however, which contributes modestly to these high percentages. Surprisingly, two lists are presented rather than an integrated one, dealing with separately with the western (by Urszula Bielczyk) and eastern (by Robert Kościelniak and Józef Kiszka) Polish Carpathians. These are again arranged alphabetically, and literature records are given by a fine system of regions and meso-regions; there are over 300 papers on the lichens of the Polish sector, so this synthesis was clearly much needed. Synomyns are cross-referenced from the index, but also listed under the accepted names in the main listing.

Both volumes are well-produced and entirely in English, and I find it commendable that the first volumes in two different biodiversity series concern lichens, rather than as one might expect, birds, butterflies, fish, or plants – a major achievement for the lichenological community of the region.

The Lichen Genera *Lasallia* and *Umbilicaria* in the Polish Tatra Mts. By Beata Krzewicka. 15 March 2004. W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland. [Polish Botanical Studies No. 17.] Pp. 88, figs 67. ISBN 83 89648 11 3. Price: € 15.

This is not just a systematic account to the single species of *Lasallia* and 20 of *Umbilicaria* in the Tatra Mountains, part of the Carpathian range (see above), but also a detailed autecological study. Keys and full descriptions are provided, together with accepted names and synonyms along with their bibliographic citations, information on chemistry and habitats, exsiccates studied, often impressively long lists detailing all collections traced from the area (taking up almost three pages for *U. cylindrica*), and distribution maps (which split pre- and post-1970 records). All but one Polish species (*U. dendrophora*) occurs in the Tatra mountains, and the study includes the first report of *U. aprina* for the Carpathians. Records of *U. arctica* proved to be based on misidentifications, and no recent sites for *L. pustulata, U. microphylla,* nor *U. polyrrhiza* were confirmed. Only four species are categorized as "very common" or "common"; most are rare to very rare, and *P. proboscidea* has declined markedly over the last 50 years. For each species there is a full-page "ecodiagram" containing information on rocks colonized, slope, aspect, insolation, humidity, shelter, altitude, and relation to vegetation belts; essential basic information if conservation programmes using transplanted material are ever contemplated in the future. While there are no illustrations of the species or their habitats, something which I found strange in an otherwise such a comprehensive treatment, scanning electron micrographs are provided of the undersides and thalloconidia of the 11 species in the area that have these structures; thalloconidia also feature strongly in parts of the key. This is a model study in combining sound taxonomy with ecology, chorology, and conservation issues, and further in nomenclatural responsibility in that the name changes in some common species that would arise from the lectotypifications proposed by Jiang-Chun Wei (1993) are not taken up (or even mentioned); formal action by the Committee for Fungi is Iawaited to irrevocably fix the application of some of the earliest names in this conspicuous lichen genus. If you are planning a detailed national or regional study on a particular lichen genus, this is a model meriting emulation. The author and her supervisor, Maria Olech, are to be congratulated on producing such an impressive regional monograph.

Wei, J.-C. (1993) The lectotypification of some species in the *Umbilicariaceae* described by Linnaeus or Hoffmann. *Mycosystema* **5**(Suppl.): 1-17.

Conidial Fungi

***Phoma* Identification Manual: Differentiation of specific and infra-specific taxa in culture.** By Gerhard H. Boerema, J. de Gruyter, M. E. Noordeloos & Maria E. C. Hamers. April 2004. CABI Publishing, CAB International, Nosworthy Way, Wallingford, Oxford OX10 8DE, UK. Pp. 470, figs 51, col. plate 1. ISBN 0 85199 743 0. Price: £ 75, US $ 140.

This book, which took 12 years to complete, integrates all papers on *Phoma* previously published by Gerhard Boerema and co-workers since the 1960s. The isolates dealt with in this book are mostly of European origin. *Phoma* species occur in all the five continents, on a variety of substrata, either as pathogens or saprophytes. The genus is fairly large and includes nearly 3000 species names, yet recognizing the genus *Phoma in vitro* or *in vivo* is scarcely a problem for mycologists.

The book is stylishly presented in 17 chapters. The Preface explains that 223 taxa are dealt with in nine sections of *Phoma,* and there is also a list of some *Phoma* species causing diseases in crops. Following the Preface, an Introduction provides an historical account of work on the genus from the 1960s and the preparation of the book from the early 1990s (Gruyter & Noordeloos 1992). Also briefly discussed are earlier interpretations of conidiogenesis in *Phoma* by Boerema (1965) and presentation of a revamped version using some of the terminolgy used by Minter *et al.* (1983) in interpreting conidogenesis. The second chapter deals with nomenclature, and lists the nine recognized sections in *Phoma* with pertinent references. The third chapter entitled Generic Characters has a composite description for the genus encompassing all nine sections, with a brief, revised description of conidiogenesis, once again blending in with the terminology used by Minter *et al.* (1983), and further an account of conidia and secondary septation. The fourth chapter deals with methods and techniques, describing a quaint way of isolating *Phoma* species into culture by using cherry decoction or prune agar when tap water agar with pH adjusted to 5.5 would do just as well. Regarding the key NaOH spot test, the concentration of NaOH used has unfortunately been omitted, so anyone intending to use this character has to refer to Boerema & Höweler (1967) or Dorenbosch (1970), where it is cited as 1M (as'1N').

The fifth chapter deals with circles within a circle, i.e. diagrammatic illustrations of the nine *Phoma* sections according to size and their relationship between sections and other genera, with a key to all sections. It seems that the naming of sections is ambiguous, because the main character of a section is shared by other *Phoma* sections as well. An example is section *Pilosa,* meaning hairy, and intended to accommodate *Phoma* species with hairy pycnidia. In fact several species of *Phoma* placed in other sections, for example, *P. anserina* in section *Phoma* is described "as semi-pilose" (p. 59); all species in *Paraphoma*, and species in section *Plenodomus* (e.g. *P. leonuri*) also have hairy pycnidia. Evidently sect. *Pilosa* seems superfluous if differentiated on this feature. Another example is *Phoma* sect. *Heterospora,* accommodating *Phoma* species with different conidial sizes and shapes, but other sections (e.g. *Macrospora*, *Phyllostictoides*, *Peyronellacea*) also include species with diverse conidia! The key to sections (pp. 20-22) shows that the main characters of a section can be common to species in other sections, resulting in overlaps.

The sixth chapter presents notes on six coelomyceteous genera which the authors suggest as adjacent or convergent, but without any tangible evidence. In the notes under the heading *Pleurophoma,* the type species is given as *P. pleurospora*, but included under that name is *Pleurophoma cava*, which for nearly 24 years (i.e. 1973-96) was known as *Phoma cava* (Boerema & Dorenbosch 1973) but was subsequently renamed *Pleurophoma cava* (Boerema *et al.* 1996) although morphologically and anatomically this fungus is not congeneric with the type species of *Phoma* or *Pleurophoma*. The genus *Ascochyta* is also dealt with, and has notes on its conidiogenesis and septation; the latter topic having previously been discussed in detail (Punithalingam 1979) as interpreted by Luttrell (1963). The seventh chapter mainly explains abbreviations used in the book.

Parts 8 to 16 (pp. 32-410) cover the nine sections of *Phoma* (A to H). Each contains a brief introduction to the sectional characters followed by a key to the taxa, descriptions of taxa in culture, illustrations of conidia, and distributional data. The first deals with section *Phoma*. The key has some flaws, for example on pages 39 and 84 the conidia of *P. herbarum* are given as (3.5-)4 - 5.5(-8) × 1.5 – 2(-3) (rarely reaching 9 μm), but to arrive at this taxon in the key one has to enter at couplets "1" and "2a" with species producing conidia up to 7 μm in length – this will lead to 31 and eventually 36a, *P. herbarum*. In order to arrive at *P. subherbarum,* described with conidia 4-5 (-6.5) × 1.5 – 2 μm, one has to enter the key at 1b and *not* 1a, and then proceed to 2a, then 31 to 31b, then 33 to 33b which leads to 39 and 39a. In the case of *P. herbicola* (p. 85) the conidial measurements are given as 5-7(-8.5)× 2– 3 μm, and one has to enter the key at 2b, "species able to produce conidia longer than 7μm" and this will lead to 46, then on to 46b, 60 b, 61b, 62b and finally 63a . *P. herbicola.* In the description of *P. herbicola* (p. 85), the reaction to NaOH is not given, but the key at 61b requires the result of an NaOH test to proceed further. There is evidence of both lumping and splitting; for example *P. crastophila,* known only from *Setaria verticillata,* is documented and illustrated by photomicrographs from the holotype showing stiff setae around the ostiole and having cylindrical conidia with a guttule at each end (Punithalingam 1981). On that basis, *P. crastophila* belongs in *Paraphoma* and would not be a synonym of *P. herbarum.* Also questionable is the placing of *P. hibernica,* which has conidia 5-8.5(-9.5) × 2-3.5 μm, as a synonym of *P. herbarum.* According to the descriptions, *P. herbarum* (conidia (3.5-)4-5.5(-8) × 1.5-2 (-3) μm) and *P. subherbarum* (conidia 4-5 × 1.5 –2 μm) appear to have almost similar conidial dimensions, but are considered as distinct on the basis of growth rates on OA.

Section *Heterospora* has 17 taxa producing macro- and microconidia of different sizes treated. Although on p. 119 a footnote states that the "breaking or splitting easily at the septa i.e. conidial fragmentation is a phenomenon not observed in conidia of true species of *Ascochyta* or *Stagonospora*", this is incorrect because it has been previously demonstrated that in true *Ascochyta* species the conidia commonly split easily at the septa (Punithalingam 1979: pl. 10, 11, 13). Section *Heterospora* is heterogeneous, a varied assemblage of unrelated taxa including *Ascochyta nigripycnidiicola*, *Phoma oculo-hominis* and *Stagonospora curtisii*. It should be noted that single conidial cultures of *A. nigripycnidiicola* produce thick-walled *Plenodomus*-type pycnidia with distinct annellides, quite unlike the phialides seen in *Phoma* (Punithalingam & Spooner 2002). Apparently, several diverse taxa from a variety of hosts have been conveniently pigeonholed here on the basis of the presence of large and small conidia. Members in this section have limited host (nutritional) preferences which seems to place a constraint on their asexual reproduction mechanism on agar media. Perhaps this might explain why on the host they produce larger, septate conidia and in culture mostly smaller aseptate conidia. Minimal descriptions of the taxa are given and this does not include details of the conidiogenous cells, and even in the synopsis the conidia have only been illustrated by line drawings. It is not known whether one conidiogenous cell produces different types of conidia or just one type of conidium. The key is not easy to use, but inclusion of the identities of the host would make matters less cumbersome. Despite Petrak (1925) having placed *Stagonosporopsis* as a synonym of *Ascochyta* and that being cited in recent editions of *Ainsworth & Bisby's Dictionary of Fungi,* it is strange that *Stagonosporopsis* continues to be used in this book.

Sect. *Paraphoma* includes 12 taxa with setose pycnidia. Unfortunately, taxa with setose pycnidia also occur in other sections of *Phoma*. There is a key, but it does not seem to have been properly checked. In the key, couplet 6b ("conidia exceeding 5.5 μm") directs one to 8 which in turn keys out to 8a *P. glycinicola* and 8b *P. briardii*. After 8, the key comes to an abrupt dead end. There is no route to reach couplet 9 and so to proceed to copulets 10 and 11. If one enters straight into 9, couplet 9b redirects the user back to itself ("9"). Also, 11a keys out *P. terricola* as having conidia 3–5 × 1.5–2 μm, so this should have been keyed from 6a "Conidia not exceeding 5.5 μm". The inclusion of *Pyrenochaeta oryzae* in *Phoma leveillei* (p. 171) is controversial because *P. oryzae* has stiff setae around the ostiole and shows both short branched conidiophores and simple conidiogenous cells producing narrow conidia 4-6 × 1.5–2 μm (Punithalingam 1980). Also the splitting of taxa, for instance the continued recognition of *P. leveillei* var. *microspora,* seems unnecessary.

Sect. *Peyronellaea* includes 16 taxa which produce characteristic chlamydospores and hyphomycetous (*Epicoccum*) conidia in culture. No teleomorph connection has been established for any member of this section. This is an artificial group comprised mainly of coelomycetes and a hyphomycete. Some taxa (e.g. *P. glomerata, P. pomorum*) have extensive lists of synonyms and misapplied names. The key is usable, but at couplet 4a, it should be noted that *Phoma glomerata* also very occasionally produces 1-septate conidia. The recognition of *P. jolyana* var. *shariensis,* based on the single character of response to temperature seems unreliable.

Sect. *Phyllostictoides* includes 41 taxa, some of which are plant pathogens, a few have *Didymella* teleomorphs, and some pose problems in their taxonomy since our knowledge of them is incomplete. One example is *Phoma exigua* var. *exigua* which is listed with many synonyms (pp. 240–254) one of which is contentious, *Ascochyta phaseolorum,* as a recent morphological and molecular study found by comparison of the ITS sequence from a recently collected *A. phaseolorum* with that of a representative *P. exigua* var. *exigua* that the two are clearly not synonyms (Fatehi *et al.* 2003) and further the *A. phaseolorum* isolate produced a *Didymella* teleomorph. Amongst the other synonyms listed under *P. exigua, A. adzamethica* is also included despite the type not being available and its identity established (Alcorn *et al.* 1976, Marasas *et al.* 1974). The teleomorph of *P. arachidicola* is cited (p. 230) as *D. arachidicola,* but on the basis of the ultrastructure of ascus development Wyk et al. (1987) considered that the teleomorph could not be included in *Mycosphaerella*, *Didymella,* or *Didymosphaeria*. Note that in the beginning of the key in couplet 1a, the symbol < (less than) has been incorrectly used (cf. couplet 4a).

Sect. *Sclerophomella* has 12 taxa displaying a range of conidiomatal structures, such as typical *Phoma*-type thick-walled pycnidia, pycnosclerotia, sclerotial bodies, or *Plenodomus*- type conidiomata at some stage of development. The key in this section is incomplete because of the lack of useful cultural data on two species. Some are identifiable from the host material, while others require cultures.

Sect. *Plenodomus* includes 32 taxa, of which only some have typical *Plenodomus*-type conidiomata like those of *Phoma lingam,* a pathogen of cultivated *Brassica* spp. and other plants, which shows a range of stromatic structures on the different host substrates. Here the identification of taxa is host based, cultural characters are not available for all, and some remain sterile on culturing. The placement of *Phoma cruris-hominis* in synonymy with *P. enteroleuca* seems far-fetched as the former produces cinnabar red colonies with a cinnabar red reverse, comes from human sources and has thin-walled pycnidia and short biguttulate conidia, whereas *P. enteroleuca* comes from *Catalpa bignonioides* and has scleroplectenchymatous pycnidia. There is only a subtle difference given between *P. lingam* and *P. sublingam*; both have similar characters, including the conidial dimensions, and are supposed to be recognized by their teleomorphs! *P. agnita* and *P. astraglina* have distinct multilocular stromatic conidiomata whereas the type species of *Phoma, P. herbarum* has simple thin-walled pycnidia. It seems incongruous that *Plenodomus* should be considered a section of *Phoma.*

Sect. *Macrospora* includes nine taxa from both monocotyledons and dicotyledons. Apparently, the ultrastructure of conidiogenesis was studied in *P. rabiei,* but not in the species chosen as the type for the section which resembles some taxa included in sect. *Heterospora* in its condial characters. Growth rate is given importance in the key to the taxa in this section.

Sect. *Pilosa* has just two taxa, including *P. betae,* a pathogen of *Beta* spp. With respect to pycnidial development in that species, Monte et al. (1989) could not give a precise account on either development or pore formation, but Monte et al (1988) reported that conidiogenesis in *P. betae* differed from that of other *Phoma* spp. in the number of different distinguishable layers in the initial papilla. The three layers described by Boerema & Bollen (1975) in other *Phoma* spp. could not be observed in *P. betae. P. betae* can be detected by its ability to produce characteristic holdfast-like structures in shallow water or on agar in a Petri dish; within 48 h at 20 °C holdfasts form where the fungus is in contact with the bottom of the dish (Mangan 1971).

The final chapter deals with 14 miscellaneous taxa, i.e. some unclassified *Phoma*-like taxa and ones with known teleomorphs.

A substantial and well-chosen list of references follows (pp. 426–445), there is a fungus name index (pp. 446–466), and also a combined host-substratum index (pp. 467–470). Inevitably, the book contains few printing errors and incorrect citations, e.g. *Microsphaeropsis olivacea* is cited as "*olivaceous*" (pp. 28, 450), *P. scrophulariicola* is cited as "*scrophulariaecola*" (pp. 252, 463; corrected in *Index of Fungi* **1**: 59, 1942). Similar erroneous citations appear in the text and final index, for instance the epithet of *Phyllosticta strelitziicola* is given as "*strelitziaecola*" (pp. 246, 463), and that of *Phoma oculo-hominis* as "*oculi-hominis*" (p. 440). Also noted is an uncommon abbreviaton "*gr.*" before the epithet "*doliolum*" (pp. 321, 323). The description of *P. lingam* is on p. 359 and not p. 351 as cited in the index (p. 455).

In this work, the morphology of conidiomata, conidia and cultural characters are the main differential characters used for identification. Some taxa have extensive lists of synonyms, but there is little indication as to how such decisions were reached, whether after examination of dried type material or on the basis of recently derived cultures. The NaOH test used does not provide in-depth information that can be harnessed. While this is key publication for all interested in *Phoma*, it must be borne in mind it has its limitation in that *only* isolates in culture can be tracked down using it; for more detailed information it it will be necessary to refer to earlier publications.

Nevertheless, the authors deserve to be congratulated for amalgamating their previous publications into a single book.

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***Sphaeropsidales*: Genus *Septoria*. [Spuogagrybiečiai (*Sphaeropsidales*): Gentis *Septoria*.]** By Vaclovas Markevičius & Aušra Treigienė. January 2004 ['2003']. Valstiečių Laikraštis, Botanikas Institutas, Žaliujų ežerų 49, LT-08406 Vilnius 21, Lithuania. [Mycota Lithuaniae/Lietuvos Grybai Vol. 10 (3).] Pp. 200, figs 103, coloured plates 8. ISBN 9986 847 71 0. Price: € 28.

While at first it may seem surprising for a whole book in this series to be devoted to a single genus, this becomes understandable when it is recognized that 205 taxa in *Septoria* are considered to occur on more that 220 host plants in Lithuania. This monograph has entries for 238 taxa, and is based on studies of over 1000 collections as well as all available literature. Most species (33) occur on *Asteraceae,* with lesser numbers on *Poaceae* (19), *Apiaceae* (18), *Fabaceae* and *Rosaceae* (11 each), and *Lamiaceae* (10). The treatments of indvidual taxa include places of publication of the names, literature references (mainly for national records rather than treatments from other regions), descriptions, notes on hosts and distribution in Lithuania and elsewhere, in many cases drawings or photographs of conidia, distribution maps, and in some instances colour photographs of infections. Keys are arranged by host family and genus, an approach that is in need of replacement by one which is organism-based, but which at least provides a pragmatic method of attributing names in the *inter regnum*. In addition to the list of scientific names treated, a comprehensive host index is provided. I made a quick comparison with the monograph of the Indian species (Muthumary, 1999; *Mycotaxon* **85**: 486, 2003), a work not cited here, and found some discrepancies in bibliographic citations of names (e.g. did the name *S. lycopersici* appear in 1881 or 1882?). I was also amused to see *Sphaeria trondicola* Fr. 1823, a sanctioned name, treated as a synonym of *Septoria populi* Desm. 1843 – another case of where the changes in Art. 59 effected at the Sydney Congress in 1981 have still not worked through; the correct name under the current *Code* should be a combination based on Fries' name (which was introduced as a replacement name for *Xyloma concentricum* Pers., *Obs. Mycol.* **2**: 101, 1799), assuming that the pertinent types are conspecific. It is consequently clear that some caution has to be exercised in bibliographical and nomenclatural aspects, and it is unclear which references or types have been personally checked by the authors. Notwithstanding these remarks, there is no doubt that this is a significant contribution to our knowledge of the genus and its species as currently cicumscribed not only nationally but also internationally.

Muthumary, J. (1999) *First Contrbution to a Monograph of Septoria species in India*. Chennai: Centre for Advaced Studies in Botany, University of Madras.

MYCOTAXON

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THESE INSTRUCTIONS WERE UPDATED **DECEMBER 2004.**

OVERVIEW

I. Determining what is suitable for publication in *Mycotaxon*
II. Preparing the text
III. Preparing camera-ready illustrations
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VI. Avoiding automatic manuscript rejection
VII. Obtaining reprints and/or web-friendly PDF files of the published paper
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I. DETERMINING WHAT IS SUITABLE FOR PUBLICATION IN *MYCOTAXON*

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   Arial 10-point regular (roman) and Arial 9-point, Bold/Bold Italic are optional.

8. **Basic Text** *Font:* Times 9-point; *Paragraph:* fully justified (preferred).

   For the main text, *briefly* introduce your subject, citing significant background literature. Document your own observations concisely and stress new discoveries. Comply with the current *International Code of Botanical Nomenclature* when describing new taxa or proposing new combinations. To minimize confusion when discussing generic epithets beginning with the same initial letter, we strongly recommend that you abbreviate one using the first **two** letters of the generic name throughout the paper (e.g., *C.* for *Cantharellus* and *Cr.* for *Craterellus)*. Names of authorities should appear only once, in a separate table or in the text near where the names are first mentioned or (if new) formally proposed. For authorities of taxa use the abbreviations cited by IPNI in the International Plant Names Index <www.ipni.org/ipni/query_author.html>, the Harvard University Herbaria database <brimsa.huh.harvard.edu/cms-wb/botanist_index.html>, or CABI's *Index Fungorum* <www.indexfungorum.org/Names/Names.asp>. *Authors of Plant Names* by Brummit & Powell (1992) and *Authors of Fungal Names* by Kirk & Amsell (1992) may also be consulted. For acceptable herbarium & collections acronyms, consult *Index Herbariorum* (Holmgren et al. 1990) <www.nybg.org/bsci/ih/searchih.html>. Authors describing new taxa are expected to cite relevant acronyms and registration numbers to facilitate retrieval of the material/data by readers and to deposit (i) type specimens in an official, public herbarium, (ii) ex-type strains in a public culture collection, and/or (iii) sequence data in GenBank. Italics should be reserved for Latin scientific names for taxa up through and including order (required) or for emphasis; common Latin terms (e.g., i.e., inter al., etc.) are be placed in Roman (regular) font.

9. **Subordinated text** *Font:* Times, 8-point (7-point is preferred in large tables but discouraged in the *Acknowledgements* and *Literature cited* sections).

10. **Acknowledgements** *Font:* Times, 8-point. *Paragraph:* no indent, left aligned, fully justified.

    Peer reviewers, at least, should be cited in this section.

11. **Literature cited** *Font:* Times, 8- or 9-point; *Paragraph:* Hanging indent, no line spaces between entries.

    Include all references cited in the text, ensuring that all references in the "Literature Cited" section are also found in the main text. Standardize abbreviations of journal and other periodical titles. See **BPH** *(Botanico-Periodico-Huntianum,* Lawrence & al. eds., 1968), **BPH/S** *(Botanico-Periodico-Huntianum/Supplementum* Bridson ed., 1991), **TL2** (*Taxonomic Literature*, Stafleu & Cowan, 1976-1988), and the *Supplements to Taxonomic*

Literature (Stafleu & Mennenga, 1992-1995) for recommended abbreviations. Authors are required to **single-space** entries (that is, do *not* separate citations by a blank line) and to follow a consistent citation style throughout. Placing references in *8 pt font* is preferred. Required are (i) using *hanging indents,* (ii) using initials for given names (surnames), (iii) universally placing author last names before initials, (iv) eliminating periods after initials, and (v) using commas *only* to separate listed authors (no "&" or "and").

EXAMPLES

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi. CAB International, Surrey UK.

Senior AA, Junior BB. 1997. Title with *Latin name* here. Mycotaxon 56: 254-272. (See **sample manuscript** <www.mycotaxon.com/authors/sampleMS.pdf> for further suggestions.)

12. Latin scientific names for all taxa up to and including order – *Fonts:* Italic (in the version of the font and style of the sentence or heading containing that name).

TEXT CLONE—After receiving editorial approval of a fully formatted document, authors submitting electronic files (preferred) are expected to prepare a text 'clone' from which *all* empty paragraph lines and graphics (including tables, but not figure or table legends) have been removed. This will facilitate export into InDesign® and PDF conversion. Any corrections of text made after editorial approval will be handled using the clone.

III. PREPARING CAMERA-READY ILLUSTRATIONS

A. ILLUSTRATION SIZE & PLACEMENT—All articles published in *Mycotaxon* begin on an **odd**-numbered (right-hand) page, so plan size and placement of illustrations within the text accordingly. When possible, place an illustration on or facing the page of text where the illustration is first mentioned (preferably on a right-hand page). Submit illustrations at the **size** that they will appear in the final publication. (Authors who cannot reduce their illustrations to publication size should contact the Editor-in-Chief for advice or permission to submit oversized copy.) Group figures to facilitate species comparisons and keep page numbers to a minimum. Figure legends belong below the illustration (preferred) or at the bottom of the page *facing* the illustration.

B. LINE DRAWINGS may be submitted as originals, digital images imported from scanned originals, or high quality reduced photocopies of original artwork. Digitally produced drawings incorporating vector information or fonts should be submitted as 600dpi **EPS** files, which describe a single page and can contain any combination of text, graphics, and images.

1. Digital files Authors equipped with computer scanners and applications such as *Adobe Photoshop®*, *InDesign®*, and *PageMaker®* can speedily convert line drawings to 300-600dpi TIFF files for insertion directly into the document. Adjustments to the image — including insertion of scales, numbers, and arrows — are easily handled in such applications. File names for **tables,** now treated as independent graphics, should be be placed below the table legends. Authors who do not submit tables in EPS format must also prepare table clones in *document format* (.doc, .rtf) by removing all borders to expedite export into *InDesign®*. At final submission, authors will submit each separate graphic needed for the final publication. See guidelines for preparation of digital photographs (*C2 below*) for further suggestions. Authors who submit digitally-prepared text with hard copy line drawings should place only photocopies of original drawings onto the final submission manuscript and submit the originals separately (without legends) as described for half-tone photographs (*C1 below*).

2. Hard copy Because line drawings convey only black and white information, they are reproduced by the same process as the main text, enabling drawings and text to be printed together. Authors who submit only hard copy manuscripts should place line drawings onto existing text pages with captions printed directly below or to the side of each drawing. With care, authors generally can reduce oversized drawings using the reduction feature on photocopiers without decreasing image quality and assemble an attractively arranged plate from the cut & paste illustrations and captions.

C. BLACK AND WHITE PHOTOGRAPHS—*Mycotaxon* prints only black & white photographs, but authors may submit color hard copy photos if necessary. Both black & white and color film-based (non-digital) photographs have a "continuous tone" requiring transformation into a separate *halftone image* before they can be printed in a magazine or on a computer printer. A halftone image consists of many variously sized and spaced dots, which are easily seen using a hand lens. Black & white halftones consist only of black dots, but all color halftones contain different sized dots of several colors (usually three plus black) spaced to achieve the desired color balance. Authors using digital or computer-generated images must **not** print such images themselves as "print-ready hard copy" but instead submit high-resolution TIFF grayscale computer files with their hard copy documents.

1. Digital grayscale halftone files Authors who submit **digital photographs** may insert all illustrations and figures into the document utilizing options provided by a publishing application (e.g. *InDesign*®). Photographic software programs such as *Adobe Photoshop*® facilitate preparation of low-resolution **JPG** files (to be used only during the peer and editorial review process) and high-resolution **TIFF** files (the only acceptable format for final submission). Illustration software programs such as *Adobe Illustrator*® should be used to convert vectored line drawings (for phylotrees) to **EPS** files. Configure final TIFF half-tone image files by selecting a *grayscale* setting and typing in dimensions that match the *exact final printed size* when printed at *300-600 dpi* (dots per inch). (TIFF files **must** be formatted in *grayscale* to allow the press to format the photographs properly before printing.) Authors who group photographs into **plates** should ensure that the contrast among individual photographs is not too great before incorporating them into the single TIFF file. *Mycotaxon* will accept photographs or plates that are shorter than the 17.5 xm print height, but plates generally should span the entire printed area width of 11 cm. Label each TIFF graphics file (for both line drawings and halftones) with the *senior* author's name and plate number (e.g., *name_pl#.tif*) **and** enter that information on a separate line above the figure legend in the text clone (e.g., *TIFF plate #*). File names for **tables,** now treated as independent graphics, should be be placed below the table legends. Authors who do not submit tables in EPS format must also prepare table clones in *document format* (.doc, .rtf) by removing all borders to expedite export into *InDesign*®. At final submission, authors will submit each separate graphic needed for the final publication.

2. Hard copy photographs When submitting **hard copy** (or electronic text + illustration hard copy) photographs or plates made by combining photographs, mount each plate onto a separate sheet of heavy white paper or matte board. Be certain to allow sufficient margins around the photograph for editorial markings and printer's directions. Write the first author's name on the reverse of *each* plate. Place no text (except for necessary numbering or lettering, arrows, and other annotations) on halftone plate faces. Print figure legends and other text separately as part of the main text. Sheridan Press will insert these halftone plates into the appropriate publication-ready text files. For plates filling the entire 11 × 17.5 cm print area, place the legend at the bottom of the text page *facing* the plate and separate the caption from the main text by a thin line. Do not border or edge photographs and plates with a line.

IV. OBTAINING PEER REVIEWS AND REVISING REVIEWED MANUSCRIPTS

Mycotaxon is unusual among scientific journals in that it is the responsibility of the authors to obtain peer reviews of their papers before submitting the manuscript. Send a copy of your fully formatted manuscript to **two** scientists in your field of study but *outside your home institution* for critical comment. If you are uncertain whom to approach for review of a manuscript, you are encouraged to send a summary or draft to the Editor-in-Chief, who will then suggest several researchers in the appropriate field.(See *Pre-submission*, below.) It is your responsibility to provide each peer reviewer with the 2001 *Reviewer's Guidelines for Mycotaxon Articles* (*Mycotaxon* 78: 539-540) and the Peer Review checklist, which can be downloaded from the journal's website. It is also your responsibility to provide each reviewer with all graphics files (generally low-resolution

.JPG files, unless more resolution is requested) and text formatted to show placement of graphics files *within* the text.

You are expected respond to suggestions to *both* reviewers by revising and reformatting your manuscript or presenting alternatives before final submission when you will address discrepancies in your cover letter to the Editor-in-Chief. *Double check* that changes have not resulted in any "widows" or "orphans" (single lines at the top or bottom of a page) before pre- and final submission to *Mycotaxon*. Authors may wish to offer junior author status to peer reviewers who make major improvements in the paper. Copies of peer reviewer comments and check lists from both reviewers *must* be included in the final submission. The Editor-in-Chief will acknowledge all peer reviewers in the closing pages of each volume, but authors urged to thank peer reviewers in the acknowledgements section. At least one reviewer must check nomenclature and author citations; this is not the responsibility of the Editor-in-Chief. Peer reviewers may E-mail their comments and checklists directly to the Editor-in-Chief.

V. SUBMISSION PROCESS

A. PEER REVIEW—Submit a fully formatted manuscript to two experts in the field for peer-review. [Two peer reviews are now required for all papers, regardless of length.] Authors should submit tentative titles and abstracts to the Editor-in-Chief *before* preparing the manuscript for peer review, if they are not certain whether their topics fall within the journals taxonomic–nomenclatural focus. The Editor-in-Chief may also aid in the search for suitable experts willing to review manuscripts.

B. PRE-SUBMISSION—After peer review but before final submission, authors with computer-prepared manuscripts are required to pre-submit (preferably as an e-mail attachment) a fully formatted text document with line drawings and half-tones removed but all other formatting in place. Low-resolution JPGs or a PDF displaying the graphics in place may accompany the text document. Authors who submit Adobe *InDesign* files do not need to submit text or graphics separately. Authors with access to the internet who plan to submit hard-copy text manuscripts should E-mail the Editor-in-Chief all title, author, address, abstract, and key word information to expedite processing. Whether computer-genderated or hard-copy, manuscripts that do not conform completely to all text formatting requirements listed above will be returned to the author for revision.

"Mycotaxon presubmission: [corresponding author name + one word manuscript name]" should be included in all presubmission E-mail subject headers, as the Editor-in-Chief will not open E-mails without subject headers.

C. FINAL SUBMISSION—After receiving editorial pre-submission approval, the author should formally submit a revised manuscript and all outstanding supporting documents to the Editor-in-Chief. Final submission may be handled entirely using E-mail when digital files are not too large and author generated PDF files contain all embedded graphics files. Otherwise submission packets should be mailed by governmental or courier postal services (*certified* and/or *signature required*) to one of the addresses on page 506. Individual E-mail attachments should not exceed 4 megabytes without express permission from the Editor-in-Chief.

1. Manuscript:

a. EITHER one PDF file OR one hard copy *with* all graphics in place. The hard copy should be printed only on one side of the paper and with author's name & page numbers on the top right corner of each text page and name & plate number on the back of each illustration.

b. computer-generated publication-ready files as E-mail attachments or on CDs (preferred), zip disks (less preferred), or PC formatted floppies (least desired). Electronic files must include (i) a fully-formatted print-ready document file with graphics (including tables) omitted, (ii) separate high resolution TIF or EPS files for each line drawing, phylotree, or halftone, and (iii) DOC, RTF, or EPS files for each table.

2. Supporting documents:

a. a cover letter that list the following *required* information in order:

__1 title

__2 author names*

*for *each* author, also note placement of accents or diacritical marks, and in compound names which is the last name (used for alphabetizing author names in indices)

__3 number of *pages, plates* (not individual figures), and *tables*

__4 type of plates—black&white line-drawing vs. grayscale halftone and how many each submitted as hard copy (halftones must have been prepared from film negatives), 300-600dpi TIF, or 600dpi EPS

__5 the senior and/or corresponding author's mailing address

__6 e-mail addresses and/or fax numbers for *all* authors

__7 names, institutional affiliations, and E-mail addresses of both peer reviewers

__8 a short paragraph explaining why any reviewer recommendations were not followed

__9 a statement indicating a willingness to pay the excess page or plate charges (to be paid after acceptance but prior to publication)

b. comments & checklists from both peer reviewers*

Instructions and checklists can be downloaded from <www.mycotaxon.com/authors/reviewers.html>

c. (only when reurn of artwork is desired) a self-addressed envelope, stamped or, for foreign authors, with sufficient International Reply Coupons to cover postage costs in full

3. Submit materials: Consult the **Author's Checklist** below as a final check of the readiness of the submission before sending to the Editor-in-Chief. Remember to prepare back-up copies, as submissions may be damaged or lost in the mail; keep a dated, print-ready computer file and/or photocopies of all materials you send to the Editor to reduce re-submission time, if necessary.

Any or all items may be sent as E-mail attachments. Those wishing the press to use their own print-quality Adobe PDF files must pre-flight their PDFs with Sheridan Press before final submission and are expected to insert the masthead font and page numbers exactly as requested after final approval and pagination. Authors also are responsible for seeing that peer reviewers E-mail their checklists and comments directly to the Editor-in-Chief. **NOTE:** Authors should always include "Mycotaxon" followed by an author name and an appropriate word in the E-mail subject header to avoid inadvertent deletion of E-mail messages by the Editor. Authors using spam filters should add <editor@mycotaxon.com> and <llnorvell@pnw-ms.com> to their list of permitted incoming addresses.

Authors who mail hard copy submission packets are reminded to **pack your submission securely,** enclose address information within the packet, and to use stiff boards, bubble wrap, and/or plastic cases to protect artwork and CDs.

VI. AVOIDING AUTOMATIC MANUSCRIPT REJECTION

The following criteria may result in **automatic rejection** of submitted manuscripts. Automatically rejected papers may be resubmitted after authors reformat the papers to meet these criteria. Carefully consider the points below to ensure that your paper is not initially rejected on formatting grounds:

A. BEFORE PEER REVIEW AND PRE-SUBMISSION

1. Use single-spacing throughout the paper: Camera-ready documents **must** be single-spaced within paragraphs; paragraphs with internal lines separated by 1 1/2 spaces between lines will be rejected. Text formatted with the **line spacing** set **one** to (rarely) two points higher than the selected text font is acceptable and will provide sufficient separation between text lines of text. Single blank lines may be used to separate paragraphs outside the Acknowledgements and

Literature cited sections but must be eliminated from the text clone at final submission. A full text page typically contains 40–48 9-point font lines, fewer than pages containg sections with subordinated formatted in 7- to 8-point fonts.

2. Select the proper font faces and sizes: Format **titles** in sentence case, 11-point Arial (Helvetica when Arial not available), bold for all words except Latin scientific names (up through order) in bold italic. Primary stand-alone section headers should be centered and in Arial 10-point bold; secondary stand-alone headers should be aligned left and in Times 10–point or Arial 9-point bold. **Main Text** must be in Times 9-point. *Mycotaxon* recommends Times 8–point font for most **subordinated materials** (abstract, Latin diagnoses, specimens examined, figure legends, acknowledgments, and literature cited) and Times/TNR 7-point font for tables. Courier is permitted for displaying DNA sequences when alignment is needed. Use of other fonts and sizes without prior editorial approval is reason for automatic rejection.

3. Select the proper font & paragraph styles: Titles must appear in "sentence case", in which only first word and proper nouns are capitalized. Use **bold** for names of all new taxa and new names of all ranks at the point in the text where they are formally described. Latin names of taxa at ordinal rank and below must be in *italics,* otherwise to be restricted to internal subheadings or emphasized terms. Names of taxa above ordinal rank may be formatted in either italic or normal typeface at the author's discretion. Do not italicize common abbreviations, such as et al., etc., inter al. Occasional use of bold face for subheadings within the text or for names of taxa within keys may be pleasing. You can also occasionally emphasize text using UPPERCASE or Large and Small Caps. (See the **sample manuscript** <www.mycotaxon.com/authors/sampleMS.pdf> for examples of font styles in technical descriptions and specimens examined.)

4. Do not underline: Although underlining is an easy option when using a computer, never underline when preparing publication-ready manuscripts. Underlining is *never* used in printed publications. To achieve emphasis use *italic*, **bold**, or (exceptionally) ***bold italic*** typeface.

5. Deactivate hyperlinks: Text clones containing active hyperlink formatting will be returned for modification. Most recent word-processing applications format email addresses or website URLs automatically in **hyperlink format**, seen as underlined text (often blue). To ensure that such hyperlinks do not appear in the final paper, authors should disable the hyperlink feature option. (MSWord users should follow Format>Styles>Styles-in-Use pathway in their menu bar to delete the Hyperlink and Followed Hyperlink styles settings. Consult your application manual for guidance on other platforms or in other applications.)

6. Headings must not occur alone as the bottom line of a page: Prevent "orphan" headings by arranging them so that there are at least two lines below a heading on the bottom of a page whenever possible. Also do **not** end any heading with a period.

7. Prevent punctuation problems: Commas, periods, and other punctuation should be in the same font style as the words immediately preceding them. Thus commas following italicized words should also be in *italics,* in bold when the preceding words are in **bold,** and in bold italic when the immediately preceding words are in ***bold italic.*** The ONLY exception is with paired marks (parentheses, square brackets, quotation marks, single quotation marks, long dashes), where the closing mark takes the same font style as the preceding open mark. With the exception of the sanctioning colon (e.g., Fr. : Fr.), no spaces should come between a punctuation mark and the text preceding it. Likewise, no space should come between an initial paired mark, such as an open parenthesis, and the following text. Only **one** space should separate sentences following a period in computer formatted manuscripts.

8. The micron symbol: *µ* can be generated in most computer text fonts by using special keystrokes (*e.g.*, "option+m" on a Macintosh or "insert symbol" on a PC). Do *not* import a micron mark from a font different from the one you are using (such as Greek). PC-users who must select *µ* from "Symbols" should place the symbol in the same-sized font as the surrounding text. Please send the Editor-in-Chief a list of all symbols that you use in your manuscript, and when at all possible select symbols from the appropriate Arial or Times font selections.

9. Learn the difference between a hyphen, an en-dash and an em-dash: A *hyphen* will break at a line end and is often used whenever the author wants to hyphenate a word manually to ensure well-populated lines in justified text. Authors who have used hyphens in the presubmission process should *remove* all such hyphens during preparation of the final submission text clones, otherwise they may appear in midline after export into *InDesign* by the Editor. An *en* dash (generated on Macintosh computers with "option+dash") is a longer hyphen that does not break at line end; the en dash is frequently used for minus signs in mathematical notation or stands for "to" in time or range as (e.g., 8–10, where the *en* dash prevents the "8-" from occurring on one line and the "10" on the next.) No spaces should come between an *en* dash and the elements it connects. An *em* dash ("shift+option+dash" on Macintosh computers) is the longest and—generally—is reserved for emphasizing observations that would otherwise be enclosed in parentheses. Keystrokes differ on a PC, but the concept is the same.

10. Check for spelling and grammatical errors. It is the responsibility of the author to proofread the manuscript for spelling, typographic, and grammatical errors. We *strongly* suggest that you use your word-processing program's grammar and spelling checker if it has one. Two common spelling errors are (i) mistakes in the author's own name (!) & address and (ii) spelling names of taxa one way in the text and another way in an illustration caption.

Non-English speakers must consult someone fluent in English (or French) to proofread the paper *before* peer review and again before pre-submitting a manuscript to the Editor-in-Chief. Additional attention should be given to Latin diagnoses, which should be brief: authors should list only key characters that separate the proposed new taxon from already published taxa. (Shorter diagnoses usually contain fewer errors than do more elaborate and complicated descriptions.)

B. BEFORE FINAL SUBMISSION

1. Remove embedded headers & page numbers: Although author name & page number headers and line numbers should be used during the pre-submission peer review process, they must not be printed on hard copy final submissions or be embedded within digital final pre-publication text clones. Add the senior author's name and page number to final hard copy using a soft pencil (blue preferable) on the top right corner of each page.

2. Print publication-ready manuscript. Hard-copy submissions should be centered within an invisible 11 x 17.5 cm "frame" on US standard letter (8.5" x 11") or A4 paper. Document settings usually can be customized in computer-generated files within the application. In the MSWord® print set-up menu, for example, authors would enter "15.2 cm x 22.8 cm" (6 in. x 9 in.) into the "custom" size box and then set margins at 4.0 cm (top, title page), 2.3 cm (top, all other pages), 2.1 cm (side), and 3.0 cm (bottom).

VII. OBTAINING REPRINTS AND/OR WEB-FRIENDLY PDF FILES

Mycotaxon no longer provides free offprints but does send *one copy* of the printed paper to the corresponding author immediately after publication to use in xerographic production of reprints. This is in addition to the pre-publication print-quality PDF file generated by the Editor-in-Chief. You may purchase reprints and/or a PDF file for web posting as soon as your article is accepted. Our posted **price list** <www.mycotaxon.com/authors/reprints.html> shows costs for 100 (or more) reprints. Prices listed for PDF files are for PDFs hosted by Sheridan Press for downloading by others. Alternatively, a local printer can make high quality reprints from the pre-publication PDF or printed copy sent to the corresponding author. *Mycotaxon* no longer returns original text or illustration materials but will return original illustrations to authors who include a *self-addressed envelope,* **stamped** or (for foreign authors), with sufficient **International Postal Reply Coupons** in their submission packet .

VIII. FINAL AUTHOR CHECKLIST

Remember that all authors are responsible for their information, spelling, and text and would benefit from pre-submission review (required for computer-generated manuscripts). Authors who submit hard copy are the primary *designer* and *printer* of their paper and acknowledge that the Editor **cannot** change submitted text.

- **Formatting** (very important)

____Fonts and paragraphs all conform to *Mycotaxon* standards as set forth in the author guidelines under *Preparing the First Draft.*

____All text is at 100% (full-scale) for a page size of 11 x 17.5 cm with margins set at 4.0 cm (top, title page), 2.3 cm (top, all other pages), 2.1 cm (side), and 3.0 cm (bottom).

____NO headers or page numbers appear in computer-submitted print-ready files or printed on camera-ready manuscript pages. *(All such notations should be kept far away from the text and added to the backs of printed hard-copy pages using a soft pencil.)*

____Text clones must have footnotes in the order where they will appear (e.g., after the text for page 1) rather than displayed as a footnote using the word-processing application.

- **Title**

____is printed in Arial 11–point font in **Bold** sentence-case with Latin names only in ***bold italics;***

____is centered on the line and starts at the prescribed distance 4.0 cm from the top of page 1.

- **Author names**

____are printed in Times 10-point Roman (regular), and are centered on the line.

- **Addresses**

____are printed in Times 9-point *italics* in lines centered on the page and

____place E-mail addresses (with the hyperlink function disabled) on first lines, all institutional & street address data on second lines, and city, zone, state/province/district, & country data on third lines.

- **Abstract & Key words**

____are printed in 8-point font and are centered on the page with indented left and right margins;

____have headers printed in **Arial** in boldface with "Key words" written as two words;

____have text printed in Times, plain font except for *italicized* taxonomic names; and

____Key words do not repeat terms or words in the title or abstract, do not exceed five in number, are separated by commas, are not capitilized (unless proper), and the line does not end with a period.

- **Single-spacing**

____is used within main text paragraphs and throughout the entire Literature cited section.

- **Latin scientific names**

____are placed in *italics* for all taxa up to and including the level of order.

- **Author citations**

____have been checked against a standard citation index

- **Literature cited**

____has been checked again to ensure all citations follow required guidelines and are otherwise consistent, and

____paragraphs are formatted with hanging indents.

- **All illustrations**

____are scaled to fit the final page ***or*** you have received editorial permission to send unreduced plates to the Editorial office.

- **Photographs or composite photographic plates**

____fill the entire width of the page (except where text or legend takes part of the width),

____are mounted separately from the text on heavy paper or board in hard-copy submissions with ample margins for editorial and press marks,

____captions are printed within the text, not on the photographic plate, and

____when in digital form are submitted according to our instructions.

- **Dated hard copy and computer files of the final manuscript**

____were saved for yourself.

- **Securely wrapped submission package or final E-mail submission includes**

____cover letter with all required items listed as set forth above,

____electronic text clone (preferrably sent as e-mail attachment)

____one publication-ready copy (hard copy or PDF file) to guide placement of figures,

____reviewer cover letters (from at least **two** peer reviewers) with checklist and comments, and

____is being mailed to the appropriate language editor.

Send **English Language** manuscripts and accompanying documents to:

Dr. Lorelei L. Norvell
Mycotaxon Editor-in-Chief
<editor@mycotaxon.com>
Pacific Northwest Mycology Service
6720 NW Skyline Boulevard
Portland, OR 97229-1309 USA

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Prof. Grégoire L. Hennebert
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All manuscripts are handled in the order in which they are received. The Editor-in-Chief generally acknowledges manuscripts within a few days of receipt, although accession slows before press deadlines and during the fall field season. Your manuscript should receive a permanent *Mycotaxon* accession number two weeks after arrival in the editorial office. The Editor-in-Chief reserves the right to reject papers of questionable taxonomic merit or those that do not meet *Mycotaxon* criteria.

The Editor-in-Chief will not grant formal approval or begin publication preparation until all required submission items are on file. Author index information and page numbers are sent with pre-publication PDF files for final author approval. Authors must send approval and/or corrections within *three working days* after receiving the PDF file or the paper will be published from uncorrected copy. Only errors introduced by the PDF conversion process will be corrected near press deadlines. These include omitted text, altered symbols, and other anomalies introduced by the Editor-in-Chief, but not minor text shifts resulting from graphics insertion and text placement.

No print-ready PDF files will be sent for author approval to authors who have sent exclusively hard copy submissions.

STILL HAVE QUESTIONS?

Contact* the Editor-in-Chief at editor@mycotaxon.com or the address above

OR check FAQ on our website at <www.mycotaxon.com>

***PLEASE NOTE:** When sending E-mail messages to *Mycotaxon*, remember to place Mycotaxon + author name + identifying word *or* your Mycotaxon accession number in subject headers to forestall unintended message deletion by the Editor. We remind you to set your spam filters or notify your system administrators to allow receipt any mail from *editor@mycotaxon.com* or *info@mycotaxon.com*. but suggest that you open only attachments with the .doc or .pdf extensions after the file name.

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Lactarius in Kumaon Himalaya 4: A new species of subgenus *Piperites*

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Abstract—*Lactarius dhakurianus*, proposed as new to science, is described and illustrated. A provisional key for all the taxa belonging to the subgenus *Piperites* collected from Kumaon Himalaya is given.

Key words—macrofungi, *Russulaceae*, taxonomy, India

Introduction

At present the genus *Lactarius* is represented by 74 taxa in India (Das & Sharma 2004, Das et al. 2004), including the new species proposed herein. The subgenus *Piperites* (Fr.) Kauffman emerges as the largest subgenus among the Indian *Lactarius*, comprising 32 taxa. During the macrofungal investigation in Kumaon Himalaya, authors (KD & JRS) collected an interesting taxon of this subgenus which appears to be undescribed and is proposed here as *Lactarius dhakurianus*.

Materials and Methods

The present communication is based on the mycological survey and exploration tour to Pindari and Sunderdhunga Glaciers and surrounding forests of Kumaon Himalaya undertaken by two of us (KD & JRS) in 1999 and 2003 respectively. Macromorphological characters were noted from the fresh specimens in the field.

Micromorphological characters were studied with the dried material rehydrated in 5% KOH and mounted in Melzer's reagent, Lactophenol-cotton blue and Congo red. Colour terms are after Kelly & Judd (1955). Line drawings of basidiomes were made by K. Das. Microscopic line drawings were prepared by K. Das & M.T. Basso with the aid of the camera lucida attachment and Nikon Eclipse 600 microscope (with bright field) and Nomarski interference contrast optics equipped with 10x, 40x and 100x (immersion) planner objective lenses successively. Density of lamellae was measured at the margin excluding lamellulae. Basidiospore length excludes the length of ornamentations and the hilar appendix. Basidium length excludes the length of sterigmata. For measurement of basidiospores, 50 (**n**) basidiospores (30 by MTB & 20 by KD) were observed. Quotient (**Q** = L/W) was calculated considering the mean value of length and width. Different terms regarding cystidia follow Heilmann-Clausen et al. (1998). The names of the herbaria used follow Holmgren et al. (1990).

Taxonomy

Based on the specimens which are hitherto collected from Kumaon Himalaya, the subgenus can be characterized as follows: pileus viscid to dry, smooth to hairy, azonate to zonate, buff to pinkish buff, brilliant to orange yellow, orange, grayish yellow, medium greenish blue to blue, margin inrolled to plane; lamellae broadly adnate to decurrent; stipe dry, cylindric or tapered towards base, mostly concolorous; latex transparent (watery), white, yellow, orange, reddish brown or blue; basidiospore ornamentation of isolated warts or of ridges in parallel or reticulate pattern; hymenial macrocystidia present or absent; pileipellis an ixocutis to trichoderm. Regarding this subgenus, existing records include only five species (Das et al. 2003, Sharma & Das 2003) from Kumaon Himalaya, the northwestern part of India, bordering Nepal. Extensive foraying followed by macro- as well as microscopic study resulted in the finding of seven more species in the region, viz., *Lactarius controversus* Pers.: Fr., *L. paradoxus* Beardslee & Burl., *L. rubrifluus* Gillet, *L. alnicola* A.H. Sm. var. *alnicola*, *L. zonarius* (Bull.) Fr., *L. deliciosus* (Fr.) Gray and *L. subpurpureus* Peck as well as the discovery of *L. dhakurianus*.

KEY TO SPECIES OF SUBGENUS PIPERITES FROM KUMAON HIMALAYA

1a. Latex watery or white 2
b. Latex orange, very red or deep to dark reddish brown or deep greenish blue to blue 9

2a. Latex watery (transparent) . . . . *L. dhakurianus*
b. Latex white 3

3a. Pileus dry, pileipellis a trichoderm . . . . *L. dafianus*
b. Pileus viscid, pileipellis an ixocutis to ixotrichoderm 4

4a. Pileus grayish, spore ornamentation of zebroid pattern. . . . . *L. maitlyensis*
b. Pileus white to yellow, spore ornamentation as partially complete to incomplete reticulum 5

5a. Pileus yellowish white to pinkish buff, azonate . . . . *L. controversus*
b. Pileus azonate or zonate, yellow, grayish yellow, orange yellow with a silvery lustre 6

6a. Latex unchanging 7
b. Latex yellow after exposure 8

7a. Pileus distinctly zonate . . . . *L. zonarius*
b. Pileus azonate . . . .*L. alnicola* var. *alnicola*

8a. Hairs at pileus margin very sticky; stipe pitted or scrobiculate . . . *L. abbotanus*
b. Hairs at pileus margin non sticky; stipe not scrobiculate . . . . .*L. mayawatianus*

9a. Latex deep greenish blue . . . . *L. subindigo*
b. Latex orange, red to dark red or reddish brown 10

10a. Latex orange to orange yellow . . . . *L. deliciosus*
b. Latex red to reddish brown 11

11a. Latex red, basidiome grows in association with *Pinus* sp. . . . . *L. rubrifluus*
b. Latex reddish brown, basidiome grows in association with *Abies* sp. 12

12a. Basidiome distinctly reddish brown after bruising; pileus margin sulcate, lamellae and lamellulae relatively distant . . . . *L. subpurpureus*
b. Basidiome distinctly bluish green after bruising, pileus margin regular, lamellae and lamellulae relatively crowded. . . . .*L. paradoxus*

Lactarius dhakurianus K. Das, Basso & J.R. Sharma *sp. nov.* **Figure 1, a–g**

Etymology: After the name of the place Dhakuri, referring to the type locality.

*Pileus 60–90 mm latus, e convexo-planoconvexus, centro leviter depressus, granulosus, viscidulus, luteo-aurantiacus vel ochraceus, margine inflexus vel reflexus. Lamellae manifeste distantes, e late adnate-adnexes, pileo concolores. Stipes 50–65 x 16–23 mm, cylindraceus, pileo concolor. Lac aquosum, pellucidum, aere immutabile. Sporae 5.7–8 x 4.2–6.3 µm, subglobosae ad ellipsoideae, verrucosae, eburneae in cumulo. Pleuromacrocystidia nulla. Pleuropseudocystidia cylindrica. Paracystidia 35–50 x 6–8 µm, cylindracea ad clavata. Pileipellis ixocutiformis, hyphis filiformibus dense intertextis constituta. INDIA, Uttaranchal, Bageswar, Dhakuri, September 19, 2003, leg. K. Das & J.R. Sharma, KD7025 (**Holotypus**, BSD; isotypus, LUG9162).*

Pileus 60–90 mm diam., convex, planoconvex with slightly depressed center at maturity; pileipellis slightly slimy, unpolished, smooth, irregularly granulose all over, light to medium orange yellow, brilliant orange yellow or ochraceous; margin incurved to decurved, regular, sometimes split **Lamellae** broadly adnate to adnexed, distant (ca. 3 per cm), concolorous with the pileus, often with brownish spots at maturity; lamellulae of similar length. **Stipe** 50–65 x 16–23 mm, cylindric or tapering towards base, upper part concolorous with pileus, paler towards base, often with irregular brown spots towards base. **Context** solid, yellowish white to pale yellow, slowly becoming slightly brownish. **Latex** transparent, watery, unchanging. **Odor** aromatic. **Taste** acrid. **Spore print** yellow white.

Basidiospores 5.7–8 x 4.2–6.3 μm, subglobose to ellipsoid (n = 50, Q = 1.28); ornamentation less than 0.5 μm, amyloid, composed of numerous irregular warts, not or rarely connected by fine lines; plage inamyloid, distinct. **Basidia** 28–50 x 6–9 μm, subcylindric to clavate, 2 to 4-spored; sterigmata up to 5 μm long. **Pleuromacrocystidia** absent. **Pleuropseudocystidia** 4–7 μm broad, irregularly cylindric with rounded apex, content dense. **Paracystidia** 35–50 x 6–8 μm, cylindric to clavate. Lamellae edge fertile. **Cheilomacrocystidia** absent. **Cheilopseudocystidia** up to 6 μm broad, cylindrical. **Paracystidia** subclavate to clavate. **Subhymenial layer** up to 28 μm thick, cellular. **Hymenophoral trama** cellular with sphaerocytes and few hyphae; cell up to 40 μm diam. **Pileipellis** an ixocutis, composed mostly of repent parallel and interwoven hyaline hyphae submerged under a very thin gluten layer; hyphae up to 3.5 μm broad. **Stipitipellis** a cutis, composed of parallel hyphae; hyphae up to 5.5 μm broad.

Ecology — *Lactarius dhakurianus* grows in association with species of *Rhododendron* and *Quercus* in moist deciduous temperate (2500–3000 m) forests.

SPECIMENS EXAMINED —– **INDIA, UTTARANCHAL**: **Bageswar**, Dhakuri, September 19, 2003, leg. K. Das & J.R. Sharma, KD7025 (**HOLOTYPE**, BSD; isotype, LUG9162); *ibid.*, September 29, 1999, leg. K. Das & J.R. Sharma, KD1008 (BSD).

Notes — *Lactarius dhakurianus* was only found at the same survey site in the forests surrounding Dhakuri. It can be easily distinguished in the field by the orange-yellow to yellow ochre pileus, distant lamellae with a single row of lamellulae and watery (transparent) unchanging latex. Microscopically, the absence of hymenial macrocystidia is also very characteristic. The ixocutis nature of pileipellis, colour of the basidiomes and latex place the present species under the subgenus *Piperites*.

L. dhakurianus resembles with the Indian species *L. himalayana* Rawla & Sarwal and the American species *L. villozonatus* G.F. Atk. However, the pale yellow pileus, the crowded lamellae with 1–3 rows of lamellulae, the pruinose stipe and the different spore ornamentation with warts "mostly joined by thinnish ridges to form a partial network with few meshes" and cutis arrangement of pileipellis separate *L. himalayana* (Rawla & Sarwal 1983) from the present taxon. Similarly, the zonate villose pileus, subdistant lamellae, the reticulate pattern of basidiospore ornamentation and the presence of pleuromacrocystidia are the characters which separate *L. villozonatus* (Hesler & Smith 1979, Burlingham 1932) from *L. dhakurianus*.

Moreover, the present species also shares some features with *L. aureifolius* Verbeken and *L. aurantifolius* Verbeken, both African species. *L. aureifolius* (Verbeken & Walleyn 1999), however, differs in the presence of white latex, lamellae with 3–5 rows of lamellulae, basidiospores with suprahilar plage and with a central amyloid spot. *L. aurantifolius* (Verbeken 1996) has white latex, white fimbriate lamellae edge and larger spores (7.4–9.6 x 5.9–7.3 μm).

LIST OF TAXA OF SUBGENUS PIPERITES FROM KUMAON HIMALAYA

In addition to the species reported from the area by Das et al. 2003 and Sharma & Das 2003, the following species can be added to the list:

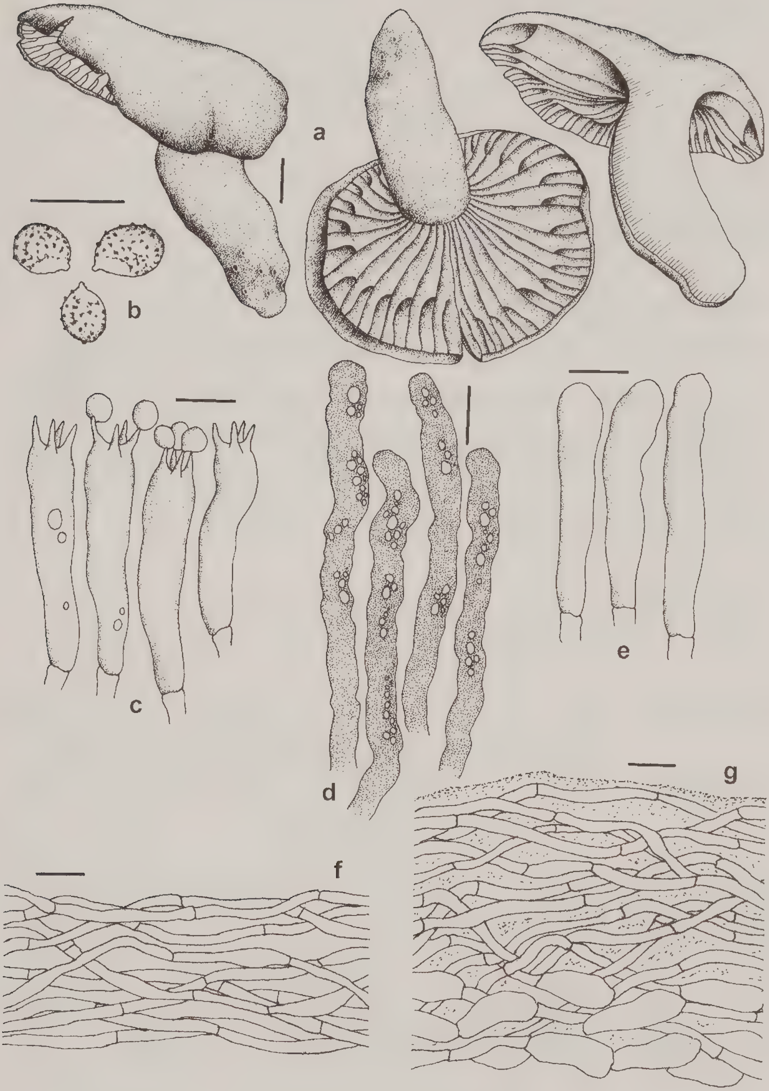

Fig.1. *Lactarius dhakurianus* (from holotype). a. Basidiomes. b. Basidiospores. c. Basidia. d. Pleuropseudocystidia. e. Paracystidia. f. Cross-section of stipitipellis. g. Cross-section of pileipellis. (Bars: a = 10 mm; b-g = 10 µm).

alnicola A.H. Smith var. ***alnicola***, Brittonia 12: 319 (1960).
Collection site: Dhakuri (Bageshwar).
Collection No.: KD1036, KD1045 (BSD).

controversus Pers.: Fr., Observationes mycologicae 2: 33 (1799).
Collection site: Mayawati forest (Champawat); Mornoula (Almora).
Collection No.: KD4555, KD4573 (BSD).

deliciosus (Fr.) Gray, Nat. Arr. Brit. Pls. 1: 624 (1821).
Collection site: Dhakuri (Bageshwar).
Collection No.: KD1007, KD1013, KD1019, KD7013, KD7016, KD7040, KD7042, KD7043 (BSD).

dhakurianus K. Das, Basso & J.R. Sharma, described here.
Collection site: Dhakuri (Bageshwar).
Collection No.: KD7025 (Holotype, BSD; isotype, LUG9162), KD1008 (BSD).

paradoxus Beardslee & Burlingham, Mycologia 32: 584 (1940).
Collection site: Dhakuri (Bageshwar); Dafia Dhura (Pithoragarh).
Collection No.: KD1052, KD4060, KD4068 (BSD).

rubrifluus Gillet, Bull. Soc. Linn. Normandie Sér II 4: 255 (1870).
Collection site: Almora (Almora); Kausani (Bageshwar).
Collection No.: KD902, KD922 (BSD).

subpurpureus Peck, Ann. Rep. N.Y. State Mus. 29: 43 (1878).
Collection site: Dhakuri (Bageshwar).
Collection No.: KD1026, KD1046, KD1042, KD1050, KD7086 (BSD).

zonarius (Bull.) Fr., Epicr. Syst. Mycol. 336 (1838).
Collection site: Gagar (Nainital); Mukteshwar (Nainital); Mornoula (Almora); Mayawati forest (Champawat); Loharkhet top (Bageshwar).
Collection No.: KD2136, KD2118, KD4562, KD4571, KD4546, KD7080 (BSD).

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Kelly KL, Judd DB. 1955. The ISCC-NBS Method of Designating Colors and a Dictionary of Colour Names. ISCC-NBS Color-Name Charts Illustrated with Centroid Colors. National Bureau of Standards Circular 553. U.S. Government Printing Office, Washington, DC.

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Hygroaster iguazuensis sp. nov. and a new continental record for *Lentinus similis*

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Abstract—*Hygroaster iguazuensis* is proposed as a new species and *Lentinus similis* is a new record for the Americas. Both fungi are fully described and illustrated.

Key words—*Hygrophoraceae,* nodulose spores, *Polyporaceae*

Introduction

During a survey of many years of the mycobiota of Iguazú National Park (Misiones, Argentina), a new species of macrofungi was encountered that merits description. A new record for the Americas was also collected.

The genus *Hygroaster* has not received much attention. When proposed by Singer (1955), who segregated his genus from *Hygrophorus* based on spore morphology, *Hygroaster* contained only one species, *H. nodulisporus* (Dennis) Singer. Singer (1986) later added another species to his genus, *H. albellus* Singer. Other authors, such as Hesler & Smith (1963), considered *Hygroaster* a part of *Hygrophorus.*

Lentinus similis Berk. & Br. has been reported from Africa, Asia and Australia, but, until now, not from the Americas.

Both species are fully described and illustrated below.

**†January 4, 2005*

Material and Methods

Specimens were collected, photographed, and dried according to the procedures given by Wright & Albertó (2002). Herbarium acronyms are according to Holmgren et al. (1990). Colors follow Maerz & Paul (1930) and Rayner (1970).

Taxonomic description

Hygroaster iguazuensis B. E. Lechner & J. E. Wright **sp. nov.** **Figures 1, 2A**

> *Pileus 6-10 mm diam. primo globoso-haemisphericus, dein convexus, parce umbonatus, aurantio vivo, nitente, hygrophanus, glabrous. Lamellae adnatae vel sinuato-decurrentibus, albae, minute pruinosis, ca. 1 mm latis. Caro alba, angustissima. Stipes 18-25 x 1-1.5 mm, pallide aurantius in 1/2 superiore, pallide ochraceus in 1/2 inferiore, semisolidus, glabrus.*
>
> *Pileipellis in cutis hyphis radialis, parallelis, afibulatis, exornatis, 2-3 μm diam. Hyphis contextu similaribus, 1.5- 5.2 μm diam. Stipitipellis idem cum pileipellis, hyphis 2.5-9.3 μm diam. Pseudocystidiis numerosis, cum granis fulvo-castaneis. Basidiolae numerosis, cum granulis fulvo-castaneis. Trama hymenophorale subparalellis. Basidiis 25.4-26 x 4-5 μm, 2- & 4-sporis. Sporis ellipsoideis, hyalinis, crassitunicatis, nodulosae, inamyloideis, polygonalis, 5-6.7 x 3.7-4.5 μm.*
>
> *Hab.: in foliis dejectis ad sylva pluviosa subtropicali, leg. O. F. Popoff, OR-3690, Argentina, Misiones, Parque Nacional Iguazú, Garganta del Diablo, 06-III-2003, in herb. BAFC 51.301 conservatus est.*

Pileus (Fig. 1A, 2A) 6-10 mm diam., at first globose-hemispheric, later convex, slightly umbonate, bright orange, shiny, hygrophanous, glabrous. *Lamellae* adnate to sinuate-decurrent, white, with a white pruina, ca. 1 mm wide. *Flesh* white, very thin. *Stipe* 18–25 x 1–1.5 mm, light orange in the upper half and light ochraceous in the lower half, not completely hollow, smooth.

Pileipellis (Fig. 1B) a cutis of radially arranged, parallel, unclamped, hyaline hyphae, 2-3 μm diam. Context (Fig. 1C) hyphae similar, 1.5-5.2 μm diam. *Stipitipellis* (Fig. 1D) as in pileipellis; stem hyphae 2.5-9.3 μm diam. All hyphae unclamped. *Pseudocystidia* (Fig. 1E) numerous, with a yellowish brown granular content. *Basidioles* (Fig. 1E) numerous, also with yellowish brown contents. *Hymenophoral trama* subparallel. *Basidia* (Fig. 1E) 25.4-26 x 4-5 μm, 2- and 4-spored. Spores ellipsoid, with a polygonal contour, thick-walled, hyaline, nodulose, IKI-, 5-6.7 x 3.7-4.5 μm (Fig. 1F).

Material studied — The holotype.

Remarks — The combination of the features above, the most important of which is the peculiar basidiospore morphology, points to the tropical genus *Hygroaster*. The new species differs from *H. nodulisporus* and *H. albellus*, based on pileus surface and/or spore size: *H. nodulisporus* has a black, silky pileus and larger (7-10 x 6-8 μm) spores while Singer (1989) described *H. albellus* as having a white to brown pileus and much larger (10-14 x 9.5-13.5 μm) basidiospores.

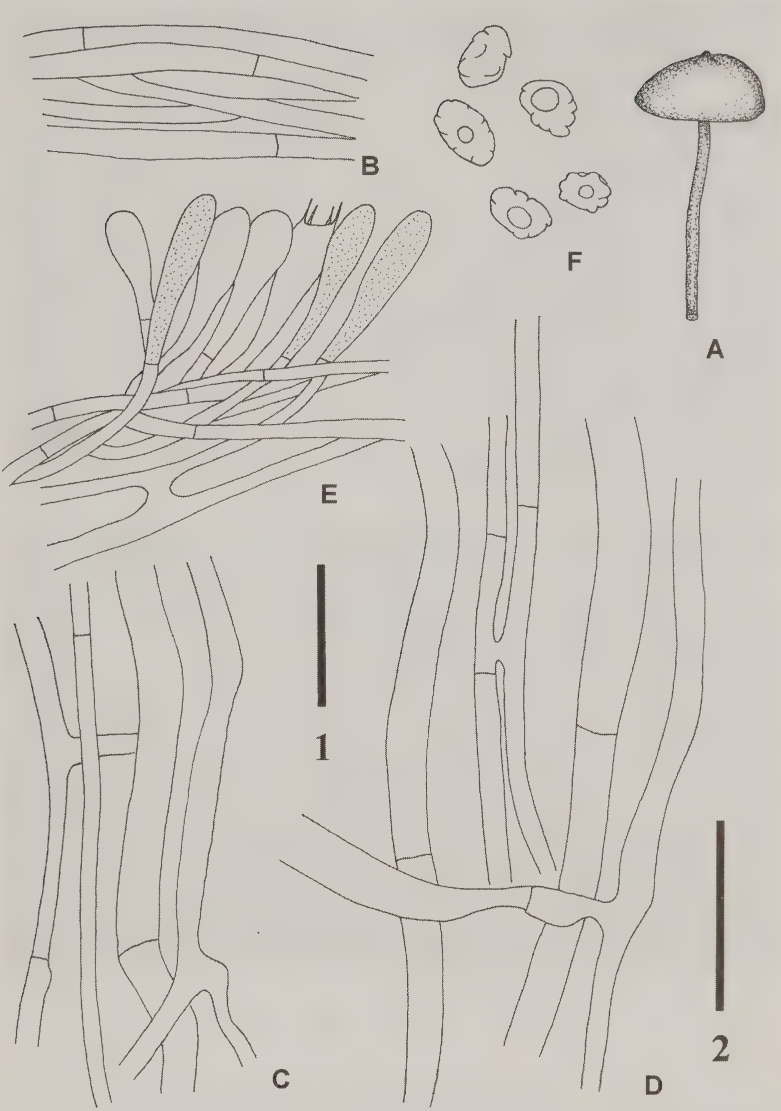

Fig. 1: ***Hygroaster iguazuensis*****: Macro- and micromorphology.** A) Basidiocarp. B) Pileipellis. C) Hyphae of the context. D) Hyphae of the stem. E) Pseudocystidia, basidioles, basidia and portion of the hymenophoral trama. F) Basidiospores. Scale bar 1= 1.5 cm for A; scale bar 2= 20 μm for B to E and 40 μm for F.

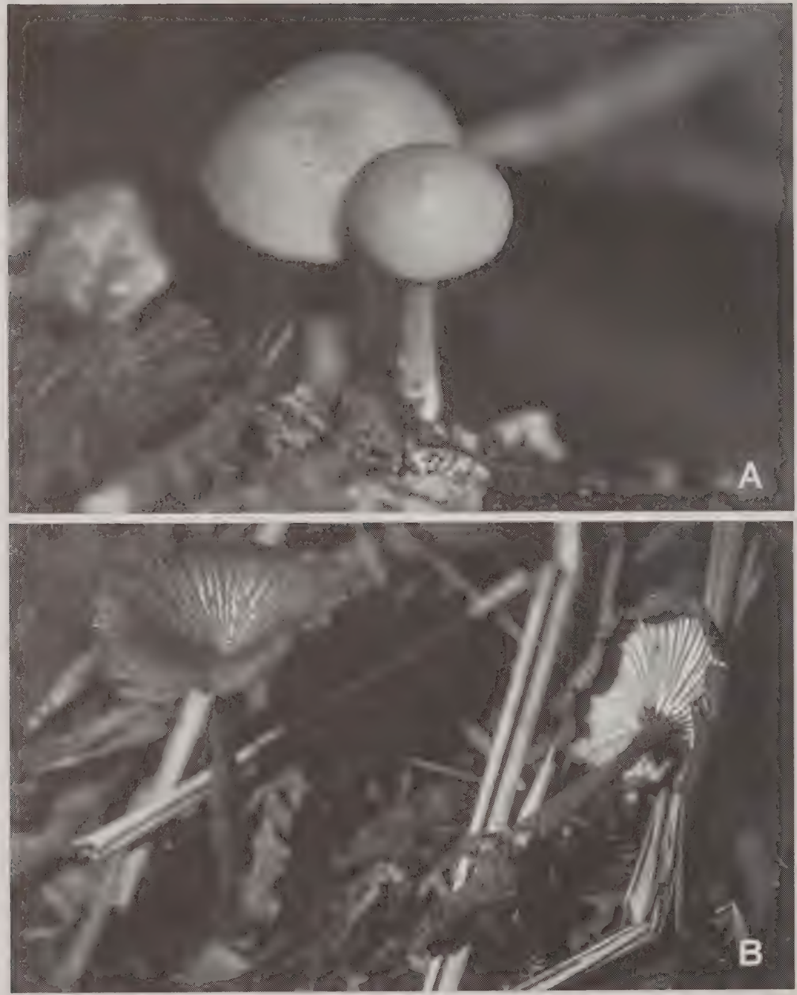

Fig. 2: A) *Hygroaster iguazuensis*. B) *Lentinus similis*.

Lentinus similis Berk. & Broome, Journal of the Linnean Society, Bot. 14: 93. 1873. **Figures 2B, 3**

Pileus (Fig. 2B, 3A) 30-50 mm diam, thin, coriaceous, deeply infundibuliform, expanding to become cup-like, finely velvety, when old almost smooth, radially striate, margin ciliate, cinnamon brown to chestnut brown. *Lamellae* decurrent, 0.5-2 mm. *Stem* central, 60-80 x 2-3 mm, cylindric, slightly expanded towards the base.

Pileipellis (Fig. 3B) a cutis, 40-70 μm thick, brown, formed by skeletal hyphae 3-6 μm diam., some protruding to form sparse hairs. *Stipitipellis* also a cutis with skeletal hyphae

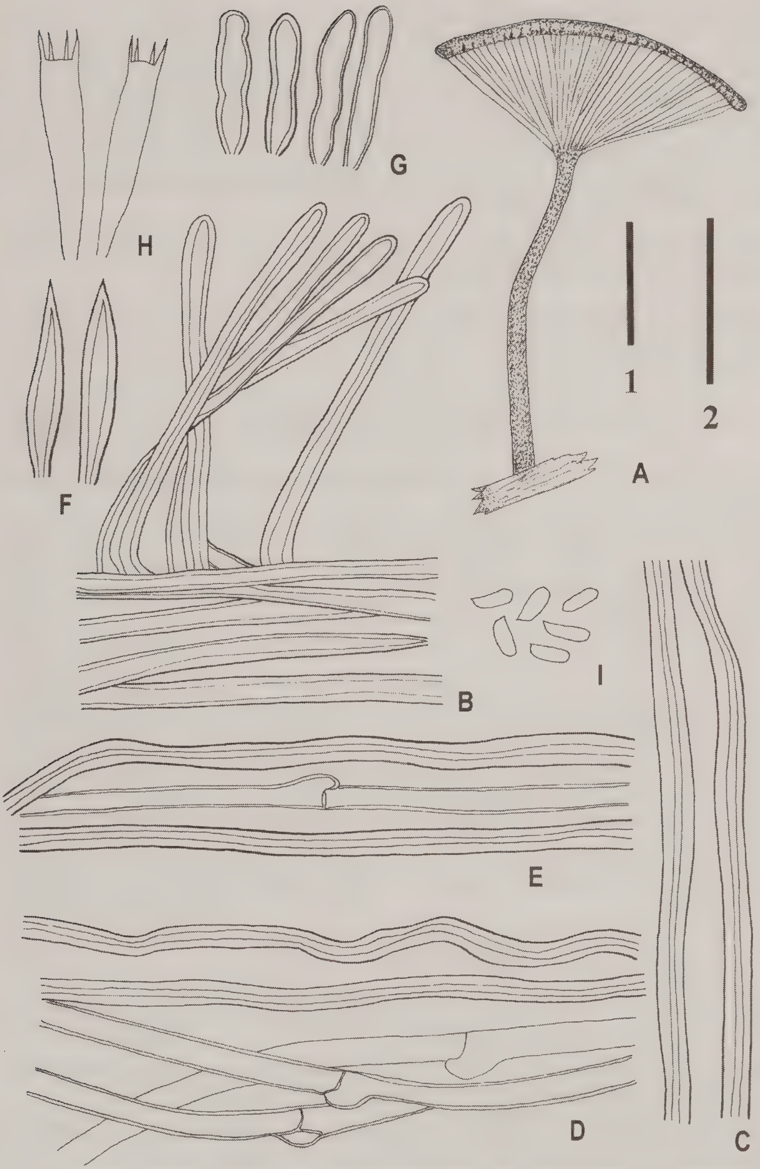

Fig. 3: ***Lentinus similis:*** **Macro- and micromorphology.** A) Basidiocarp. B) Pileipellis. C) Hyphae of the stem. D) Hyphae of the hymenophoral trama. E) Hyphae of pileus context. F) Sclerocystidia. G) Pleurocystidia. H) Basidia. I) Spores. Scale bar 1= 2.5 cm for A; scale bar 2= 20 μm for B to I.

3-4 µm diam., forming a velvety, brown surface. *Stem hyphae* (Fig. 3C) skeletals, 3-4.5 µm diam. *Hymenophoral trama* (Fig. 3D) completely irregular, formed by almost solid skeletals, 3-5 µm diam., and thick-walled, clamped, generative hyphae, 3-4 µm diam. *Subhymenium* not distinct. *Context hyphae* (Fig. 3E) similar to hymenophoral trama, 3-4.5 µm diam. *Cheilocystidia* constricted, thick-walled, 15-20 x 4.5-6.5 µm. *Sclerocystidia* (Fig. 3F) 25-35 x 4-5. *Pleurocystidia* (Fig. 3G) with a slightly acute apex, 26-27 x 4-5 µm. *Basidia* (Fig. 3H) 4-spored, 32-33 x 4.5-5 µm. *Spores* (Fig. 3I) short cylindric, hyaline, smooth, 5-5.5 x 2.5-3 µm.

Material studied — ARGENTINA: Misiones, Iguazú National Park, El Palmital, 5-III-2003, *leg. O. Popoff, OR-3669* (BAFC 51.298).

Remarks — *Lentinus similis* is found in Africa, Asia and Australia but unrecorded so far for the Americas. This is the first record for western hemisphere. Our material fully conforms to Pegler´s (1983) description of the species.

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A new species of *Alternaria* on cosmos seeds

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Abstract- This paper describes and illustrates a new species, *Alternaria cosmosa*, detected and isolated from seeds of yellow cosmos. It differs from other species of *Alternaria* in spore size, cultural characters and pathogenicity.

Key words- seed-borne pathogen, flower plant, *Cosmos sulphureus*

Introduction

Seed is a very good substratum for the survival and development of many fungi. *Alternaria* is one of the commonest seed-borne fungi on different crops (Richardson 1979). Some species of *Alternaria* are saprophytic whereas others are pathogenic to plants. Plant pathogens may be introduced to distant countries or continents along with seeds. For example, *A. carthami* Chowdhury, *A. protenta* Simmons, *A. tagetica* S.K. Shome & Mustafee and *A. zinniae* M.B. Ellis were detected on flower seeds imported into Taiwan (Chou & Wu 1995; Wu & Wu 2003; Wu & Yang 1992; Wu et al. 2001). The demand for imported flower seeds has risen with the increasing amount of flower consumption in Taiwan. Cosmos is a popular flowering plant. *A. zinniae* was reported to exist on cosmos seed (Richardson 1979). This paper reports a new species of *Alternaria* detected on cosmos seed. It resembles *A. carthami* but has its own characteristic morphology and pathogenicity.

Taxonomic Description

Alternaria cosmosa Y.L. Li & W.S. Wu, sp. nov. (Fig. 1)

Ex cultura in agaro V-8 descripta. Conidiophora solitaria, in colonia dispersa, simplicia vel ramose, ad ca. 55–270 × 7.5–10 µm, modice brunnea vel brunea.Conidia solitaria, rarissime 2-catenata; anguste obclavata, multitranseptata, dein longe ovoidea, 50–110 (80.35) × 15–25 (19.15) µm (corpus), 112.5–287.5 (215.05) × ca. 2-6 µm (rostrum); 7–12 transverse et 0–3 longitudine septata. Rostra filamentosa, interdum uniramosa. Habitatio typi in semen Cosmos sulphureus. Holotypus: partes ex cultura CCRC 33661, desiccatae et in Culture Collection and Research Center, Food Industry Research and Development Institute (FIRDI), TAIWAN conservanda.

Etymology: Latinized from *Cosmos*, the genus name of the host plant.

On V-8 juice agar, conidiophores erect, simple with a single terminal conidiogenous site, straight or flexuous, septate, brown or olivaceous brown, 55-270 μm long, 7.5-10 μm thick. Conidia solitary, straight or curved, obclavate, constricted at the septa, mid brown, smooth, rostrate, producing mostly a single beak, occasionally 1-branched, usually 50-110 (80.35 in average) μm long, 15-25 (19.2 in average) μm wide with 7-12 transverse septa, and 0-3 longitudinal septa; beak 112.5-287.5 (215.05 in average) μm long, 4-6μm wide at the base, tapering to 2μm with up to 11 transverse septa.

Evidence to treat *A. cosmosa* as a new species is based on the criteria described by Rotem (1994), Simmons (1992) and Yu (1992), mainly including the morphology and size of conidium and conidiophore both on cultural media (e.g. potato carrot agar, hay agar, V-8 juice agar) and natural substrata, cultural characters, the presence or absence of catenation and beak, and pathogenicity tests. Pure culture of this species was made on potato carrot agar (PCA) and V-8 juice agar (V8) irradiated under cool white light (2200 lux) or near ultra violet (NUV, 254 nm, SANKYO DENKI, FL 20SBLB Japan) at 25° for 10 days. Naturally infected seeds of yellow cosmos (*Cosmos sulphureus* Cav.) were incubated on moistened blotter in Petri dishes. Fifty conidia were selected randomly from each treatment were used for measurement. This species produces larger conidia on seeds than on PCA or V8 (Table 1). *A. cosmosa* produces larger conidia on V8 than on PCA when incubated under the same conditions. A branched beak is more frequently formed when this species is cultured on V8 under NUV compared to other treatments.

Alternaria alternata, A. zinniae and *A. carthami* have been detected on seeds of yellow cosmos (Chou & Wu, 1995; Srivastava & Gupta, 1982). The morphology of *A. cosmosa* is similar to *A. carthami* (CCRC 33657, FIRDI, Taiwan). For confirmation, conidial shape and size, cultural characters, and pathogenicity tests were studied. After culturing these two species on PCA and V8 under diurnal cool white light (12 hr.) at 25° for 10 days, the conidium body and beak of *A. cosmosa* is larger and much longer than *A. carthami* (Table 2). *A. cosmosa* cultured on PCA, PDA and V8 under diurnal NUV (12 hr.) at 25° grew faster, and covers the whole agar plate (8.5 cm in diam.), 1-2 days earlier than *A. carthami*. In addition, *A. cosmosa* produces indistinctly zoned colonies on cultural media while *A. carthami* produces clearly zoned colonies on these three media. *A. carthami* generates grayish white aerial hyphae on PCA and PDA, but blackish hyphae on V8.

To conduct pathogenicity tests, conidia of *A. cosmosa* and *A. carthami* harvested from V8 agar plates were used to prepare spore suspensions at the concentration of 1×10^5 conidia/ml. 0.1% Tween 20 was added. Healthy yellow cosmos was atomized with this spore suspension and kept under moist conditions for 24 hr. Afterwards, disease development was examined every day for 30 days. Each treatment (plus healthy control) consisted of 10 plants and experiments were repeated twice. After 3 days of inoculation with *A. cosmosa*, leaves of yellow cosmos became wrinkled, curled and withered, while *A. carthami* caused only tiny brownish spots on leaves by 30 days after inoculation. Furthermore, 20 additional species of crops in nine families have been used for inoculating *A. cosmosa* (Appendix 1). Ten plants of each species growing to the 4-5 true leaf state were used. Spore suspensions of *A. cosmosa* were prepared as above.

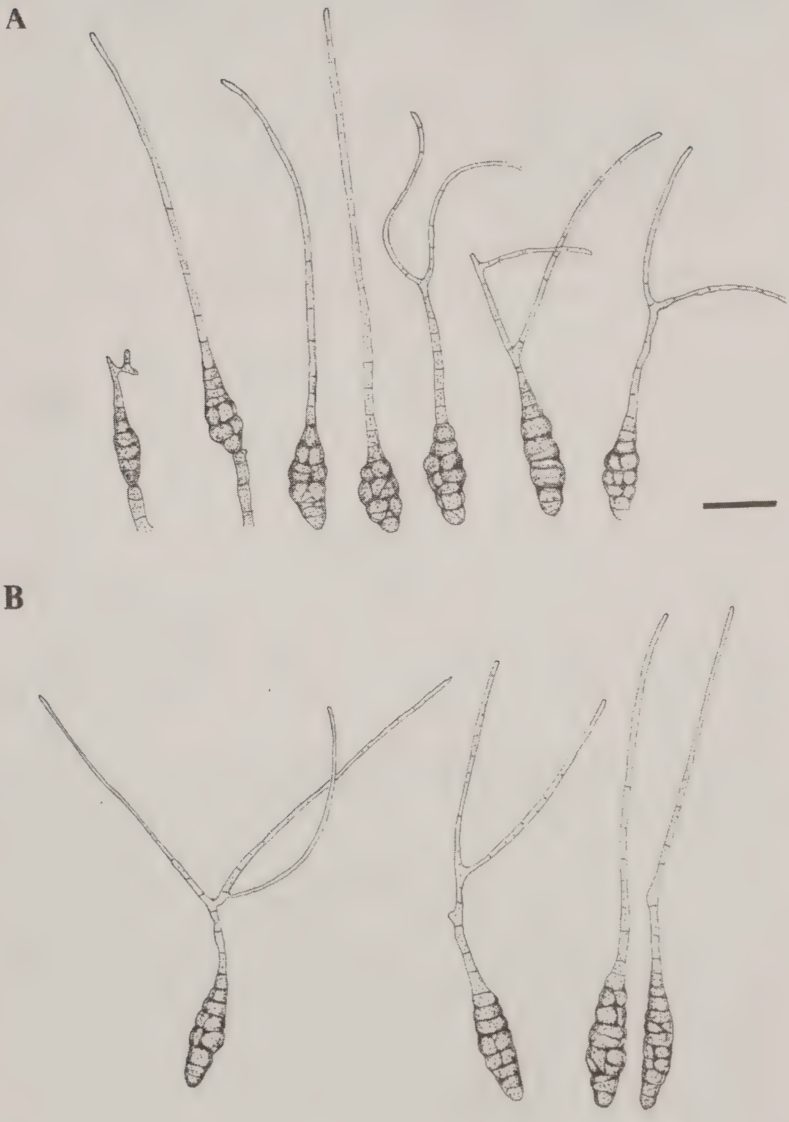

Fig.1. Conidia of *Alternaria cosmosae* collected from (A) cosmos seed and (B) V8 juice agar. Bar=50 μm.

Table 1. Effect of potato carrot agar (PCA), V8 juice agar (V8) and diurnal (12h) cool white (CWL) or near-ultraviolet light (NUV) on *Alternaria cosmosa* morphology under 25°

Medium	Treat-ment	Size of conidia [1] (μm) (without beak)	Beak length (μm)	# of trans-verse septa	# of longitu-dinal septa	# of septa in beak	% spores with branched beak
PCA	CWL	50-100 x 15-22.5	137.5-287.5	6-11	0-4	3-13	10
		(76.4 × 18.93)	(208.4)	(8)	(2)	(8)	
V8	CWL	50-110 x 15-25	112.5-287.5	7-12	0-3	1-11	10
		(80.35 x 19.15)	(215.05)	(8)	(1)	(5)	
PCA	NUV	62.5-102.5 x 15-25	125-312.5	6-11	0-4	3-11	22
		(79.25 x 22.5)	(222.25)	(7–8)	(2)	(7)	
V8	NUV	155-262.5 x 12.5-25	75-200	5-11	0-4	1-9	32
		(212.7 x 19)	(146.0)	(8)	(2)	(6)	
Seed		162.5-337.5 x 15-25	95.5-250	6-12	0-4	4-9	20
		(255.7 x 19)	(174.4)	(9)	(3)	(5)	

[1] Size of 50 spores (mean value in parenthesis).

After inoculation for 10 days, disease occurred only on cosmos (*Cosmos bipinnatus* Cav.) and yellow cosmos. No symptoms appeared on the other crops tested. *A. cosmosa* was reisolated from infected tissues.

Although overlapping size and variable shape of conidia are the problems in identification *Alternaria* spp. under different conditions (Rotem, 1994), *Alternaria cosmosa* belongs to *Noncatenatae* as delimited by Neergaard (1945) described and is a new filament-beaked species. Based on overall studies, the newly described *A. cosmosa* is characterized by its long spore beak, and shows specific pathogenicity to cosmos and yellow cosmos (Appendix 1). Judging by the symptom expression on its host plants, this species may produce some host-specific toxin or toxins. Otherwise the host plant would presumably show other types of symptoms instead of instant withering.

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Table 2. Comparison of the conidial morphology of *Alternaria carthami* and *A. cosmosa* cultured on potato carrot agar (PCA) and V8 juice agar (V8) and incubated at 25° with near ultraviolet light (12 hr.) for 10 days.

Fungus	Medium	Size of conidia (μm)	Beak length (μm)	# of transverse septa	# of longitudinal septa	# of septa in beak
A. cosmosa	PCA	50-100 x 15-22.5 4	137.5-287.5	6-11	0-4	3-13
		(76.4 x 18.93)	(208.4)	(8)	(2)	(8)
	V8	50-110 x 15-25	112.5-287.5	7-12	0-3	1-11
		(80.35 x 19.15)	(215.05)	(8)	(1)	(5)
A. carthami	PCA	48-82.5 x 12.5-25.5	45-97.5	5-9	4-6	1-4
		(70.0 x 20.0)	(90.0)			
	V8	52.5-80 x 15-25	52.5-97.5	5-10	3-6	2-4
		(72.5 x 17.5)	(95.0)			

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Simmons EG.. 1992. *Alternaria* taxonomy: current status, viewpoint, challenge. *In Alternaria* Biology, Plant Disease and Metabolites. Eds. J. Chelkowski and A. Visconti. Elsevier Science Publishers B.V., the Netherlands. 573 pp.

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Appendix 1. Pathogenicity test of *Alternaria cosmosa* on different crops determined by the appearance of symptom

Family Name	Scientific Name	Common Name	Pathogenicity
Amaranthaceae	*Gomphrena globosa* L.	globe amaranth	no
Caryophyllaceae	*Dianthus caryphyllus* L.	carnation	no
	Dianthus japonica L.	Japanese dianthus	no
Compositae	*Calendula officinalis* L.	pot marigold	no
	Cosmos bipinnatus Cas.	cosmos	yes
	Cosmos sulphureus L.	yellow cosmos	yes
	Dahlia hortensis Guill.	dahlia	no
	Gaillardia aristata Pursh.	blanket flower	no
	Helianthus annuus L.	sunflower	no
	Senecio cruentus Hybriden.	cineraria	no
	Tagetes erecta L.	American marigold	no
	Tagetes patula L.	French marigold	no
	Zinnia elegans L.	zinnia	no
Cucurbitaceae	*Cucumis sativus* L.	cucumber	
Labiatae	*Salvia splendens* Ker.	scarlet sage	no
Leguminosae	*Vigna ungriculata* (L.) Walp. subsp. *unguiculata* (L.) Verdc.	cow pea	no
Plumbaginaceae	*Limonium sinuatum* Mill.	statice	no
Solanaceae	*Capsicum annuum* L.	sweet pepper	no
	Lycopersicon esculentum Mill.	tomato	no
	Solanum melongena L. var. *esculentum Nees.*	egg plant	no
Umbelliferae	*Daucus carota* L.	carrot	no

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A new species of *Alternaria* on seeds of French marigold

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Abstract- *Alternaria patula* isolated from seeds of French marigold is described as a new species. It can be distinguished from the closely related species *A. tagetica* by characteristics in sporulation, spore size, and host range.

Keywords- seed-borne pathogen, ornamental plant, *Tagetes patula*

Introduction

The consumption of ornamental plants has increased in Taiwan in recent years. Most flowering crops are propagated from seeds. Flower seeds are mostly imported from foreign countries, e.g. Japan, USA and the Netherlands. *Alternaria carthami* Chowdhury, *A. protenta* Simmons, *A. tagetica* S.K. Shome & Mustafee and *A. zinniae* M.B. Ellis were detected in Taiwan on imported seeds of zinnia, sunflower, marigold and zinnia, respectively (Chou & Wu 1995; Wu & Wu 2003; Wu & Yang 1992; Wu et al. 2001). The presence of *A. carthami* on zinnia seed was the new record internationally. These species were described earlier (Ellis 1971, 1976; Simmons 1982, 1986). When we examined seed-borne fungi of imported French marigold, a species of *Alternaria* distinguished by its different morphology was detected. The purpose of this paper is to introduce this new species based on its characteristic morphology and pathogenicity.

Taxonomic Description

Alternaria patula H.C. Wu & W.S. Wu, sp. nov. (Fig.1)

Ex cultura in agaro PCA, PDA, V8 descripta. Conidiophora simplicia, ca. 15-150 × 6-10 μm. Conidia solitaria, ovoidea, basi rotunda et apice obtuso vel subacuto, plerumque rostellata vel longus rostrum, varie cellae hypertrophiens.Conidia privus rosrtum usque ad ca. 92-163 × 30-73μm, fulva vel brunnea, laevia, transverse 6-10 et ex parte longitudinaliter 5-14 septate, eurostello filamentoso usque ad 0-250 × 2 μm. Habitatio in semen Tagetes patula L. Holotypus: pars ex cultura CCRC 33662, desiccatae et in Culture Collection and Research Center, Food Industry Research and Development Institute (FIRDI), TAIWAN conservanda.

Etymology: *Patula* indicates its source, the species name of French marigold.

Alternaria patula occurs on seeds of French marigold (*Tagetes patula*) in moist chambers with sparse erect condiophores, 100-200 × 8-12 μm, and unusual conidia. Conidia are solitary with a long filamentous beak, greenish brown to brown, smooth, ellipsoid or oval, frequently distorted in center, up to 100-112.5 × 40-47 μm, with 6-13 transverse septa and 7-13 longitudinal or oblique septa. Beaks flexuous, 200-250 × 2 μm. Condiophores on cultural media, i.e. PCA, PDA and V8, are ca. 15-150 × 6-10 μm and erect solitarily. Most conidia remain solitary on the tip of conidiophore. The size of conidia is in a range of ca. 92-163 × 30-73 μm, with 6-10 transverse septa and 5-14 longitudinal septa. The beak is subhyaline and ca. 0-250 × 2 μm.

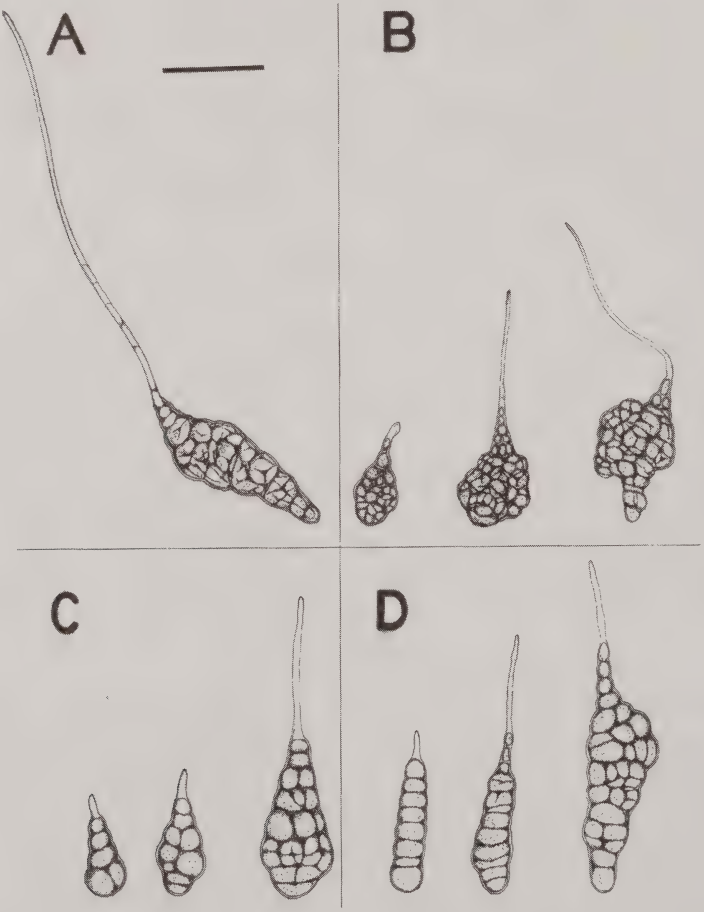

Fig. 1. Conidia of *Alternaria patula* collected from (A) French marigold seed, (B) V8 juice agar, (C) potato carrot agar, and (D) potato dextrose agar. Bar=50 μm.

Cultures of *A. patula* were established by single spore isolation and culture on potato carrot agar (PCA), potato dextrose agar (PDA) and V-8 juice agar (V8) under diurnal light (12 hr. dark/12 hr. cool white light, 2200 lux) at 25 C for 9 days. Colonies of *A. patula* on PCA show more whitish gray aerial mycelia than the morphologically closely related species *A. tagetica* under the same culture conditions. Also, *A. patula* produces much more dense, dark greenish, zonate colonies on PDA, while *A. tagetica* produces effuse colonies without zonation. *A. patula* produces larger conidia on PDA than on PCA or V8 (Table 1). Conidia of *A. patula* bear short beaks or no beak on PCA and PDA. Conidia of *A. patula* on PCA and V8 initially have a symmetrical growth and septation pattern, but later became to be followed commonly by cell distention or markedly distorted or hyperplasia (Fig. 1). *A. patula* produces larger conidia, with more septation, but shorter beaks, than *A. tagetica* on any cultural media. Conidiophores of *A. patula* are long, erect, and produce a single apical conidium, while *A. tagetica* possesses short and branched geniculate conidiophores bearing 1-2 conidia. Additionally, *A. patula* fails to sporulate on water agar but *A. tagetica* does.

Table 1. Comparison of the morphology (average of 40 conidia) of *Alternaria patula* and *A. tagetica* cultured on water agar (WA), V8 juice agar (V8), potato carrot agar (PCA), and potato dextrose agar (PDA).

Fungus	Medium	Size of conidia (μm) (without beak)	No. of transverse septa	No. of oblique septa	Beak length (μm)
A. tagetica	WA	75.0-125.0×20.0-35.0 (89.9×25.1)	5-9	2-9	125.0-300.0 (202.9)
	V8	87.5-120.0×20.0-37.5 (108.8×30.0)	5-10	5-12	150.0-300.0 (205.6)
	PCA	62.5-112.5×17.5-30.0 (93.8×22.8)	7-9	3-8	137.5-375.0 (226.5)
	PDA	70.0-135.0×17.5-30.0 (98.4×31.1)	5-10	1-10	7.5-115.0 (49.7)
A. patula	V8	100.0-137.5×32.5-47.5 (118.0×39.5)	6-10	7-13	125.0-250.0 (179.2)
	PCA	92.5-135.0×30.0-40.0 (117.1×36.4)	6-10	7-13	0-137.5 (22.5)
	PDA	95.0-162.5×30.0-72.5 (128.4×48.4)	6-12	5-14	0-87.5 (10.4)

Among 12 different plants in three families, *A. patula* is able to infect sunflower and sweet pepper while *A. tagetica* does not (Table 2). Both species are able to infect marigold, French marigold, tomato, cucumber and melon. Yu and Lee (1989) reported that sunflower is not one of the host plants of *A. tagetica*. When *A. tagetica* infects marigold, a yellow halo around a dark-brown necrotic lesion occurs (Cotty et al., 1983). When *A. patula* infects French marigold, no halo forms around the brownish lesion, but infected leaves wither within 2-3 days. Joly (1967) considered host range was a more important criterion than catenulation, and classified 22 common species of *Alternaria* into three sections, i.e. *Claroseminae*, *Brunneoseminae* and *Rigidae*. Generally, phytopathologists consider pathogenicity is a practical and reliable characteristic to differentiate species in the same genus. However, Joly's key is regarded to be oversimplified (Rotem, 1994).

Table 2. Comparison of the host range between *Alternaria patula* (Ap) and *A. tagetica* (At) determined by symptom expressed (+) or not expressed (-)

Tested plant			Pathogenicity test	
Family name	Common name	Scientific name	Ap	At
Compositae	Aster	*Callistephud chinensis*	-	-
	Yellow cosmos	*Cosmos sulfureus*	-	-
	Gaillardia	*Gaillardia picta*	-	-
	Sunflower	*Helianthus annuus*	+	-
	Mariglod	*Tagetes erecta*	+	+
	French marigold	*Tagetes patula*	+	+
	Zinnia	*Zinnia elegans*	-	-
Cucurbitaceae	Melon	*Cucumis melon*	+	+
	Cucumber	*Cucumis sativus*	+	+
Solanaceae	Sweet pepper	*Capsicum annuum*	+	-
	Tomato	*Lycopersicum esculentum*	+	+
	Tobacco	*Nicotiana tabacina*	-	-

Discussion

More than 20 different seed-borne microorganisms have been found on *Tagetes*, e.g. *T. erecta* and *T. patula*. Among these seed-borne microorganisms, *A. tagetica* is an important seed-borne pathogen. The morphology of *A. patula* is similar to *A. tagetica* (CCRC 33663, FIRDI, Taiwan) rather than *A. zinniae* (CCRC 33655, FIRDI, Taiwan). This is why we used *A. tagetica* as a comparison. Although there is no monograph or world-wide accepted key to identify *Alternaria*, the morphology, spore size, number of septa of the conidium body, length of beak, shape of conidiophore and pathogenicity tests are important characteristics to differentiate and identify *Alternaria* species (Rotem, 1994; Simmons, 1992; Yu, 1992). Ellis (1971, 1976) arranged 44 species of *Alternaria* according to the transition from their conidial body to beak and the presence as well as length of the beak. Neergaard (1945) segregated different species of *Alternaria* into three groups, i.e. *Longicatenatae*, *Brevicatenatae* and *Noncatenatae*. Currently, catenulation is not regarded as a reliable criterion for identification of species. Conidia of species in *Noncatenatae* possess either beakless, otherwise often bear long beaks. Chou and Wu (2002) preliminarily verified that the filament-beaked *Alternaria* species form a monophyletic group different from the other species. Based on Neergaard's treatise, *A. patula* belongs to *Noncatenatae*. Although *A. patula* produces a strikingly different shape of conidia on media, especially on V8, than *Alternaria panax* Whetzel does (Simmons, 1982), the morphology of *A. patula* is quite different from *A. panax* produced on its natural substrata. According to the aforementioned characteristics, *A. patula* is warranted to be a new species in this study.

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First record of *Hydnodon thelephorus* from Belize, Dominican Republic, Mexico, with new data on its morphology and distribution

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Abstract—*Hydnodon thelephorus* is redescribed based on specimens from Belize, Dominican Republic, and Mexico. New data on macro and micromorphology as well as on spore ornamentation under SEM is provided. Its systematic affinities are discussed and its overall distribution is reviewed.

Key words—stipitate hydnoids, *Thelephorales,* tropical mycobiota

Introduction

Banker (1913) proposed the genus *Hydnodon* based on *Hydnum thelephorum* Lév. This species was described as having pileate-stipitate basidiomata with orange-like to red colored hydnoid hymenium and minute whitish echinulate spores. Maas Geesteranus (1963) and Jülich (1981) noted the presence of abundant inflated hyphae, with ampuliform clamps and septa, but spores were described as verrucose and cyanophilic. This taxon has been classified in such disparate families as *Hydnaceace* (Banker 1913, Miller 1933, Harrison 1973), *Gomphaceae* (Maas Geesteranus 1963), *Thelephoraceae* (Donk 1964) and *Hydnodontaceae* (Jülich 1981).

Known to be restricted to the neotropics, *Hydnodon thelephorus* (Lév.) Banker has previously been found in the Bahamas, Bolivia, Brazil, Chile, Colombia, Costa Rica, French Guyana, Galapagos Islands, Jamaica, Panama, and southeastern USA (Coker & Beers 1951, Maas Geesteranus 1963, Ryvarden 2002). It is recorded herein from Belize, Dominican Republic and central and southern Mexico.

Methods

All specimens were annotated in the field and examined in the laboratory following standard techniques as described by Cifuentes et al. (1986) and Largent et al. (1980).

Basidiomata colors were matched either with Kornerup & Wanscher (1978) or Munsell (1975), color notation is indicated in brackets. Spore ornamentation was studied with a SEM (JEOL JSM-5310LV) following O´Donnell's (1979) technique modified by Espinosa (pers. com.), at Laboratorio de Microscopía Electrónica de Barrido, Facultad de Ciencias, UNAM. Herbaria acronyms follow Holmgren & Holmgren (1995) and Holmgren et al. (1990).

Taxonomic description

Hydnodon thelephorus (Lév.) Banker. 1913. Mycologia 5: 297.
≡ *Hydnum thelephorum* Lév. 1844. Ann. Sci. Nat. Bot. III 2: 204.
≡ *Pseudohydnum thelephorum* (Lév.) Lloyd. 1919. Myc. Notes 59: 859.
≡ *Thechispora thelephora* (Lév.) Ryvarden. 2002. Synopsis Fung. 15: 32.
= *Thelephora padinaeformis* Mont. Syll. Crypt. 175. 1856.
= *Pseudohydnum guepinoides* Rick. 1904. Ann. Mycol. 2: 409.

Pileus 19-65 mm wide, flat-convex to infundibuliform (Fig 1a, b), white, yellowish-white, pale yellow, pale orange to orange brown *[4A2, 4B3-5C3-4, 6C-D4, 2.5Y7/4–8/4]*, toward the margin whitish-yellow to pale yellow *[4A2-3, 10YR7/8–6/8]*, surface smooth sometimes rimose at center and areolate toward margin, hygrophanous, margin decurved to involute, entire, lacerate to flabellate and somewhat imbricate. **Hymenophore** tuberculate or made of cylindrical to aculeate and decurrent spines, up to 2 mm in length, close to crowded near stipe, smaller and scattered toward margin, pale to grayish orange-like, pale red to orange-brown-like *[5B4, 6A-B3, 7A3-7C4, 7D5, 8C4]* with pale yellowish to pale orange-like *[4A3-4A4]* aculeate to fimbriate tips (Fig. 1d). **Stipe** 30-50 X 3-6 mm, central, eccentric to lateral, subcylindrical to flattened, gradually attenuate towards base, simple or branched either since its base or from the middle, yellowish-white to cream-like color *[4A2-3]* though flesh color or grayish orange upwards *[6B3-4]*, surface smooth or longitudinally rugose, basal mycelium white, abundant, forming fine white mycelial cords, base appearing felted. **Context** fleshy-cartilaginous, solid, rather dry and brittle, though hygrophanous banded or mottled, white. Odour polypore-like and taste farinaceous.

Basidiospores 3.9–6.1 X 2.7–5.2 μm, subglobose to ellipsoid (Q = 1.10-1.48), pale red to vinaceous rose-like color in mass, under the photonic microscope pale yellow in KOH 5%, ornamentation cyanophilic, verrucose (Fig. 2f), with indistinct hilar appendix. Ornamentation under SEM formed by conic warts with rounded tips (Fig. 2b, c), warts fused in pairs when immature (Fig. 2a), hilar appendix appears indistinct as well. **Basidia** 19-28.6 X 4.6-7.6 μm, sterigmata 2.9-5.9 μm long, subclavate to sphaero-pedunculate (Fig. 2d), hyaline in KOH 5%, with basal clamp (Fig 2e), mostly tetrasporic, rarely bisporic, maturing from spine base towards tip and forming the spine outer layer. **Cystidia** absent. **Spine trama** parallel to subregular, mainly two kinds of hyphae observed: a) thin walled generative hyphae 1.5-5 μm wide, frequently simple clamped (Fig. 3d) or rarely ampuliform clamped (Fig. 3a), and b) scanty inflated hyphae up to 10 μm wide (Fig. 3c), but occasionally gloeoplerotic or generative hyphae with ampuliform septa are also found. **Pileus and stipe trama** irregular, four kinds of

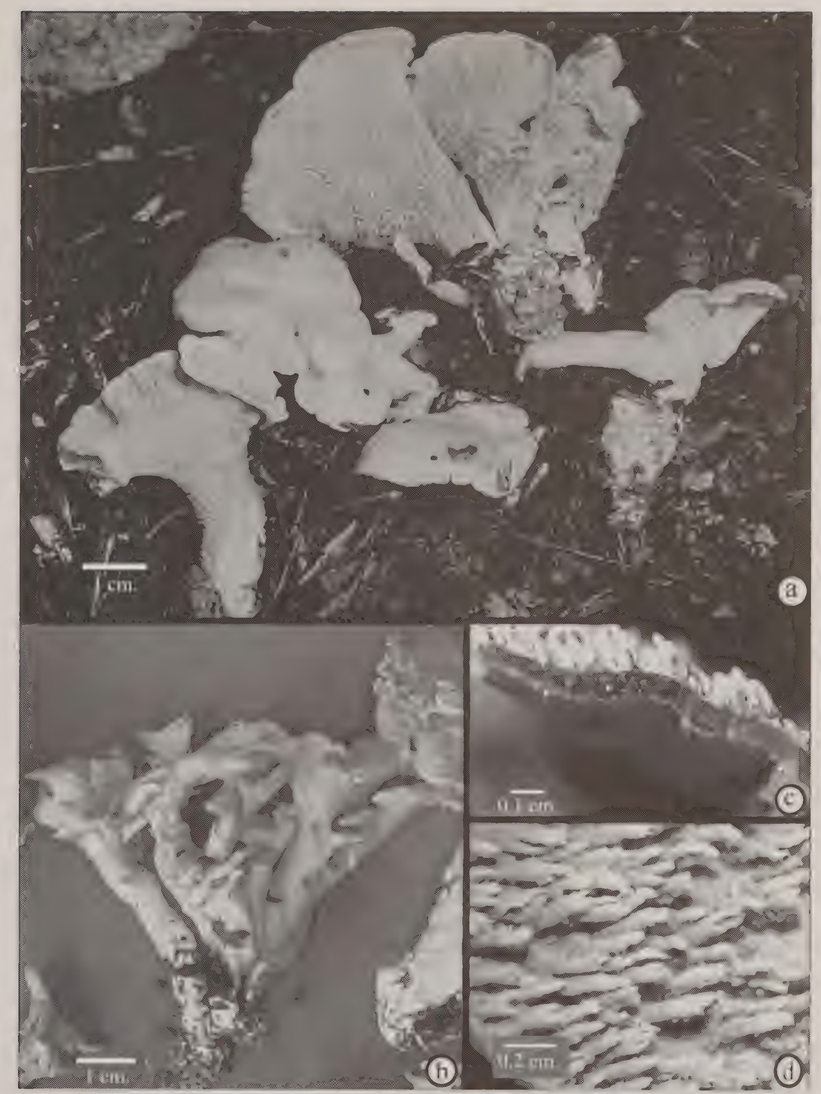

Fig. 1. a-b: Basidiomata a: T.J. Baroni 8391, photo T.J. Baroni; b: Villegas 2166, photo S. Sierra; c: Pileus longitudinal section showing the contex; d: Hymenophore detail (Estrada-Torres 6230), photos c and d Patiño-Conde.

hyphae observed: a) thin-walled to somewhat thick-walled generative hyphae 1.4-7.7 µm wide, sometimes forming H connections (Fig. 3b),frequently simple clamped or occasionally ampuliform clamped, b) abundant thin-walled inflated hyphae up to 20 µm wide, c) scanty gloeoplerotic hyphae sometimes with globose endings (Fig. 3f), and d) scanty generative hyphae with distinct ampuliform septa, 3-4 µm wide. **Basal mycelium** made of four kinds of hyphae: a) thin-walled generative hyphae 3-4 µm wide, with scanty clamps either simple or ampuliform, b) skeletized generative hyphae with simple clamps and frequently ornamented with irregular shaped yellowish crystals (3e), c) inflated hyphae, and d) generative hyphae with ampuliform septa.

Ecology, Range, and Distribution Basidiomata subgregarious to gregarious. On soil in tropical and subtropical forests. In Mexico altitude range 200 to 1380 m, fruiting from July to November. This species is known only from the Americas; its distribution area runs from southeastern United States to Chile.

Specimens examined – **BELIZE. CAYO DISTRICT:** Humming Bird Hwy, Caves Branch Resort – 2.VIII.2001 *Cifuentes 2001-177* (FCME 20141). **MEXICO. CAMPECHE:** Mpio. Ixpujil, Escárcega-Chetumal Hwy., Calakmul Biosphere Reserve, Km 21-25 on detour to Calakmul archeological zone Calakmul – 26.X.2002 *Villegas 2266* (FCME 19426) – 27.X.2002 *Villegas 2283* (FCME 19425) – 22.IX.2003 *Villegas 2405* (FCME 20142) – 25.IX.2003 *Cifuentes 2003-575* (FCME 20143). **HIDALGO:** Mpio. Mezcapala – 24.VIII.1978 *Sosa 250* (ENCB). **QUINTANA ROO:** Mpio. Benito Juárez, Puerto Morelos, CIQRO Dr. Alfredo Barrera Marín Botanical Garden – 13.XI.1983 *Escalante 180* (XAL) – 1.IX.1985 – *Suárez Díaz 97* (ENCB); Mpio. Chetumal, Experimental Forestal Camp San Felipe Bacalar – 23.VIII.1973 *Frutis 97* (ENCB); Mpio. Lazaro Cárdenas, Ecological Reserve El Eden – 24.XI.1999 *Estrada-Torres 6230* (TLXM). **VERACRUZ:** Mpio. Catemaco, Arroyo Agrio – 28.VIII.1972 *Ventura 5898* (ENCB); Mpio. Huatusco, road Totutla-Huatusco, near Huatusco – 28.VIII.1986 *Bandala 1011* (XAL). **DOMINICAN REPUBLIC. VEGA PROVINCE:** Casabito – 06.VII.1997 *T.J. Baroni 8391* (CORT). **SANTIAGO PROVINCE:** Los Montones – 27.VIII.1999 *T. J. Baroni 9024* (CORT).

Comments and Discussion

This taxon is quite distinct among stipitate hydnoids because of the pale red to vinaceous–pink color spore print and the fleshy-cartilaginous context, sometimes described also as fleshy gelatinous or semigelatinous (Coker & Beers 1951, Maas Geesteranus 1963, Cifuentes 1996). Microscopically it is distinguished by spores with cyanophilic warts, monomitic hyphal system made mainly of inflated hyphae and different types of generative hyphae.

Context consistency is difficult to observe due to a gelatinous hyaline matrix, which easily dissolves in KOH mounts. Based on this character Coker & Beers (1951) considered this taxon as *Pseudohydnum* Rick [non *Pseudohydnum* P. Karst. 1868]. Anyway, Moore (1965), in an ontogenetic study, showed that the central gelatinous matrix in *Pseudohydnum gelatinosum* (Scop. : Fr.) P. Karst. develops after hyphae disintegration, a pattern quite different from that of *Hydnodon thelephorus*.

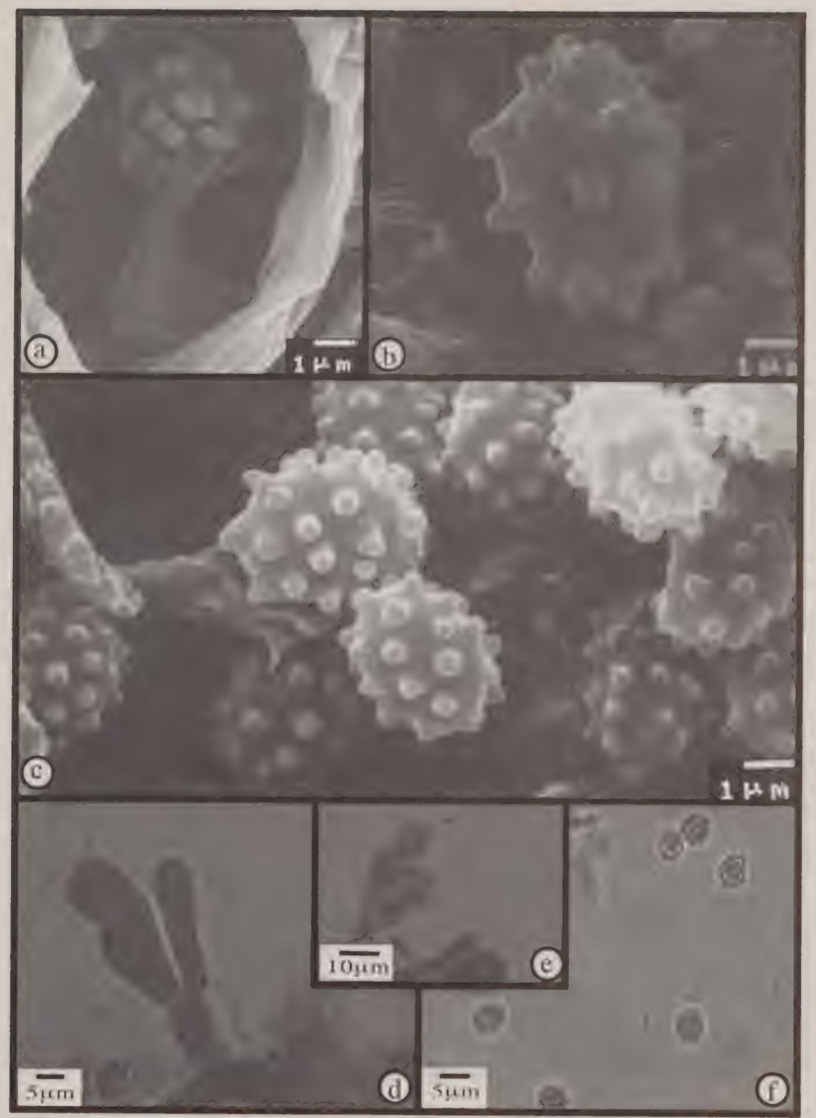

Fig. 2. a: Immature spore with characteristic two warts ornamentation under SEM (Bandala 1011); b: Mature spore with simple warts under SEM (Bandala 1011); c: Spores showing conic warts with rounded apex under SEM (Suárez-Díaz 97); photos a-c S. Espinosa; d: 4-sterigmate sphaeropedunculate basidium (Villegas 2166); e: Basidium with basal clamp (Villegas 2166); f: Echinate spores under photonic microscope (Estrada-Tores 6230); Photos d-f Patiño-Conde.

Although the hyphal system has been described as monomitic for this taxon, several kinds of hyphae can be discerned in all basidiome parts. The proportion and arrangement of different hyphae vary in every trama: for example, skeletized hyphae are more abundant in the stipe context and basal mycelium while inflated hyphae are predominant in the pileus context.

Spore ornamentation has been misleadingly described, as either echinulate (Banker 1913) or echinulate–verrucose (Maas Geesteranus 1963). Our study shows that spore ornamentation is warted, sometime paired when immature, always with rounded tips. The hilar appendix is rather indistinct, rarely seen even in mature spores.

According to Jülich (1981), the presence of ampuliform septa and clamps are diagnostic of *Hydnodontaceae* where he placed, among others, *Hydnodon* and *Trechispora*. Recently Ryvarden (2002), who used those characters to support *Hydnum thelephorum* as a *Trechispora,* proposed the new combination *Trechispora thelephora* (Lév.) Ryvarden. Larsson (1992), however, restricted *Trechispora* to species with ornamented spores showing a suprahilar plate, which we did not observe in spores of *H. thelephorus*. Ryvarden (2002) also proposed *Trechispora hypogetum* (Maas Geest.) Hjortstam & K.H.Larss. and *H. thelephorus* as taxonomic synonyms. Nevertheless our study shows that spore ornamentation is warted, and its dimensions differ from those found in *T. hypogeton*. Additionally the characters used by Ryvarden are also found in several clavarioid or hydnoid genera such as *Beenakia, Lentaria, Ramaria* and *Scytinopogon*, which are clearly distinct genera belonging to different families (Corner 1970, Petersen 1988, Jülich 1981). For these reasons, we prefer to retain *Hydnum thelephorum* in the genus *Hydnodon* until generic relationships and limits are formally evaluated and a robust phylogenetic hypothesis be proposed at the generic level.

Maas Geesteranus (1963) suggested a phylogenetic link between *Hydnodon* and the clavarioid genus *Scytinopogon* based on the presence of crystals in the hyphal mycelia at the base of the stalk, the shape of the ornamentation of the spores, and the positive cyanophilous reaction of the spores, further suggesting that *Gomphaceae* would be the appropriate family for both. Donk (1964), however, included *Hydnodon* in *Thelephoraceae* (based on its similarity with other hydnoid members in this family) and *Scytinopogon* in *Clavariaceae*. The combination of characters in *Hydnodon* has thus led to various polemic taxonomic classifications, but none with a clear consensus. It is hoped that more molecular data and cladistic analyses will help clarify and support a more robust hypothesis about the phylogenetic affinities of *Hydnodon* with other genera; such research is currently being conducted by the authors.

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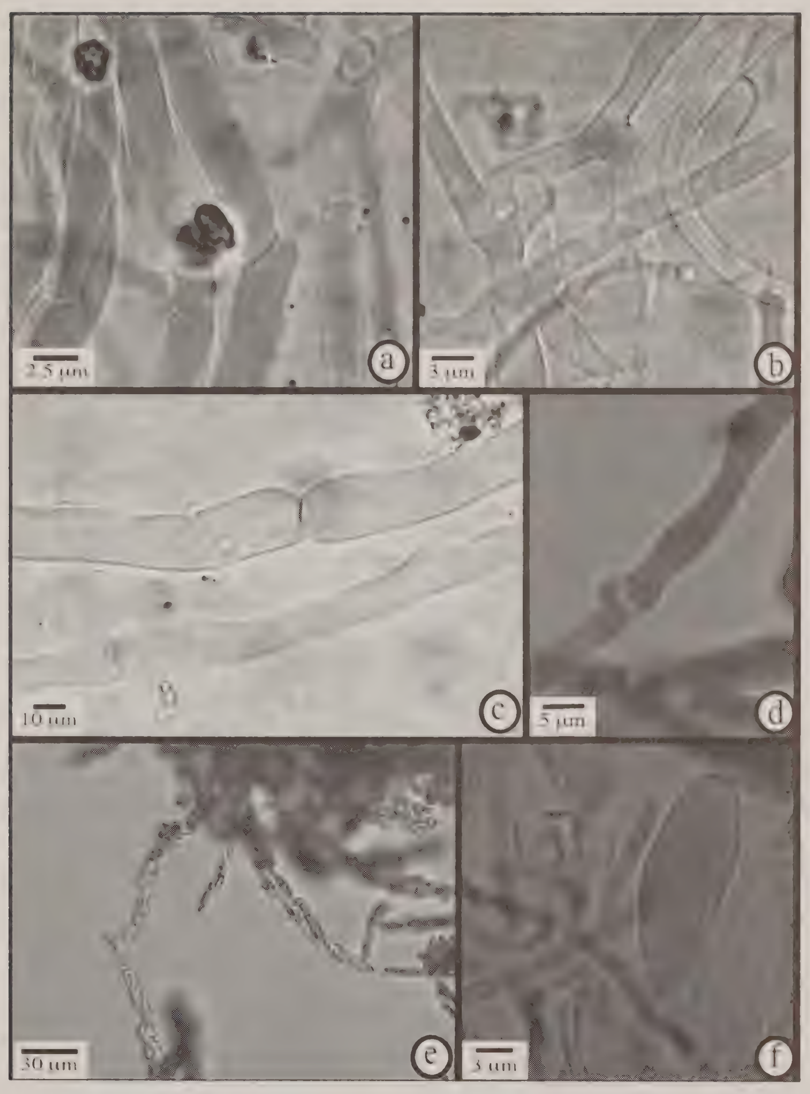

Fig. 3. a: Generative hyphae with simple and ampuliform clamps; b: Generative hypha with an H connection; c: Inflated hypha (Estrada-Torres 6230); d: Simple clamp; e: Basal mycelium hyphae ornamented with crystals (Villegas 2283); f: Gloeoplerotic hypha with swollen end (T.J. Baroni 8391). Photos a-f Patiño-Conde.

9525902 and DEB-0103621), and joint venture agreements with the USDA-Forest Service, Forest Products Lab. Support for work in Belize was kindly provided by Ms. Ava Davis, Programme for Belize, The Conservation Division, Belize Forestry Department, and Mr. Ian Anderson. For support in the Dominican Republic we are especially grateful to Sr. Andres Ferrer of the Fundación Moscoso Puello, Sra. C. Cassanova, G. Dobler, J. G. Torres, the staff of Fundación Plan Sierra, Ing. M. Mejia and Sra. D. Rodríguez.

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MYCOTAXON

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Biogeography and hosts of poroid wood decay fungi in North Carolina: species of *Coltricia, Coltriciella* and *Inonotus*

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Abstract – Distribution and host plants are given for 4 species of *Coltricia*, 1 species of *Coltriciella* and 8 species of *Inonotus*. Species checklists and figures can be accessed at: http://www.cals.ncsu.edu/plantpath/Personnel/Faculty/Grand/mycotaxon_3.pdf

Key words – fungus distribution, polypores

Introduction

Grand & Vernia (2004a,b) previously addressed the importance of biodiversity and biogeography of fungi. Studies of poroid wood decay fungi in North Carolina have provided information on the occurrence and host plants (Grand and Vernia 2002, 2003; Jung 1987; Vernia & Grand 2000). In continuing studies of poroid wood decay fungi in North Carolina, Grand and Vernia reported on the occurrence and host plant species of *Phellinus* and *Schizopora* (2004a) and *Ceriporia*, *Ceriporiopsis* and *Perenniporia* (2004b). This report is the third in a study of this group of fungi in North Carolina and evaluates species of *Coltricia*, *Coltriciella* and *Inonotus*.

Materials and methods

Details of study sites, collection and identification procedures were presented in Grand & Vernia (2004a).

Briefly, species of fungi on plant hosts were intensively collected from 1997-2003 by the authors. Data from other studies (Grand et al. 1975, Jung 1987), collections in the Mycological Herbarium (NCSC), North Carolina State University, records of the Plant Disease and Insect Clinic, Plant Pathology Department, NCSU were used in developing the distribution maps. Likewise, data from the BPI website (Farr et al. n.d.) provided some county data.

Collections were made of all uncommon species of *Coltricia, Coltriciella* and *Inonotus*, unusual forms of these species and species on new or unusual hosts. Specimens were identified using existing taxonomic treatments (Gilbertson & Ryvarden 1986, 1987; Overholts 1953). Nomenclature and authorities are from Gilbertson & Ryvarden (1986, 1987) and Kirk & Ansell (1992) for fungi and Kartesz & Kartesz (1980) for host plants.

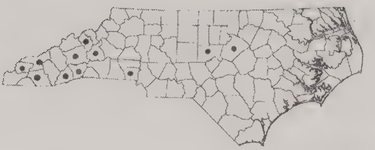

Fig. 1. Distribution of *Coltricia cinnamomea* in North Carolina

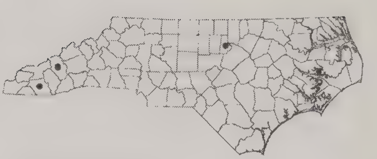

Fig. 2. Distribution of *C. foccicola* in North Carolina

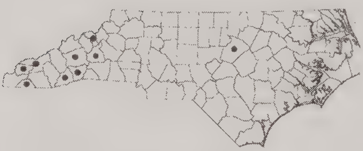

Fig. 3. Distribution of *C. montagnei* in North Carolina

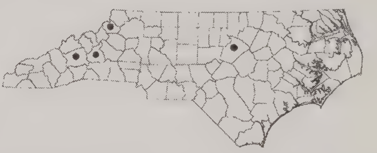

Fig. 4. Distribution of *C. perennis* in North Carolina

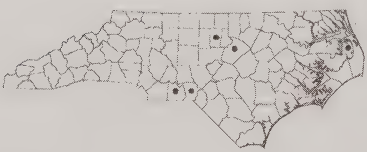

Fig. 5. Distribution of *Coltricella dependens* in North Carolina

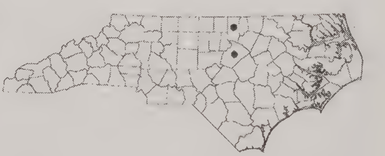

Fig. 6. Distribution of *Inonotus andersonii* in North Carolina

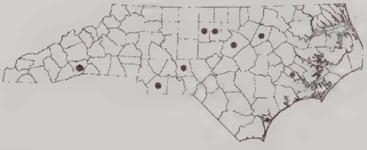

Fig. 7. Distribution of *I. dryadeus* in North Carolina

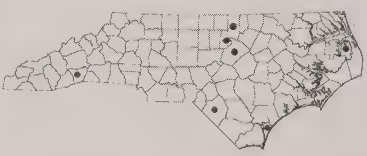

Fig. 8. Distribution of in *I. dryophilus* North Carolina

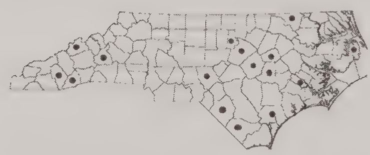

Fig. 9. Distribution of *I. hispidus* in North Carolina

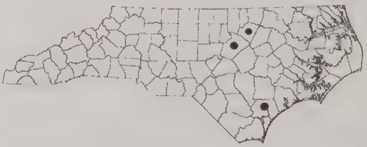

Fig. 10. Distribution of *I. ludovianus* in North Carolina

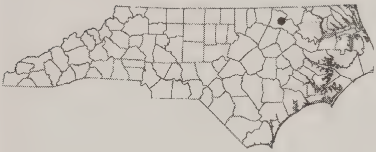

Fig. 11. Distribution of *I. obliquus* in North Carolina

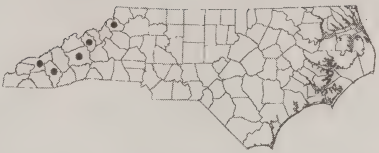

Fig. 12. Distribution of *I. radiatus* in North Carolina

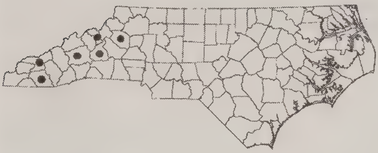

Fig. 13. Distribution of *I. tomentosus* in North Carolina

The majority of collection sites were in state parks, game lands and natural areas, Nantahala, Pisgah, Croatan and Uwharrie National Forests, the Blue Ridge Parkway and the Great Smoky Mountains National Park. A county distribution map is provided for each species (Figs. 1-13).

Results and discussion

Four species of *Coltricia*, one species of *Coltriciella* and eight species of *Inonotus* were found in North Carolina.

Coltricia cinnamonea, C. foccicola, C. montagnei and *C. perennis* appear to occur primarily in the mountains of North Carolina with very few collections made in the Piedmont of any species. No species of *Coltricia* were found in the Coastal Plain (Figs. 1-4).

Coltriciella dependens appears to be distributed in the Piedmont and Coastal Plain of North Carolina but may be more widely distributed (Fig. 5). Gilbertson and Ryvarden (1986) indicated it is a rare species in the eastern United States but easily overlooked because of its small size, color and habitat. We confirm this statement having found specimens in all five sites under or in well-decayed pine logs. Abundant ectomycorrhizae of pine were associated with the decayed logs and basidiocarps in all collections.

Inonotus radiatus and *I. tomentosus* were found only in the mountains of North Carolina (Figs. 12, 13) while *I. dryadeus* and *I. dryophilus* were found in the Piedmont and Coastal Plain (Figs. 7, 8). *Inonotus hispidus* (Fig. 9) appears to occur in the mountains, Piedmont and Coastal Plain provinces. *Inonotus andersonii, I. ludovicianus,* and *I. obliquus* (Figs. 6, 10, 11) were not collected sufficiently to establish a distribution pattern. It does appear, however, that *I. ludovicianus* (Fig. 10) may reach its northern limits in North Carolina (Gilbertson & Ryvarden; 1986).

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A contribution to the rust flora *(Uredinales)* on *Zygophylloideae (Zygophyllaceae)* in Africa*

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Abstract—Five African species of rust fungi infecting the plant subfamily *Zygophylloideae* are described in detail and illustrated by line drawings, three of which are described as new: *Uromyces dinteri* (Anamorph *Uredo zygophylli*) on *Tetraena decumbens* (= *Zygophyllum decumbens*) and on cf. *Tetraena* sp., *Uromyces namaqualandus* on *Roepera cordifolia* (= *Zygophyllum cordifolium*) and on cf. *Roepera* sp., and *Uromyces paulshoekensis* on cf. *Roepera foetida* (= *Zygophyllum cf. meyeri* = *Zygophyllum foetidum*). Furthermore, we examined *Uromyces trollipi* on *Roepera foetida* (= *Zygophyllum foetidum*) and *Uredo zygophyllina* (= *Uredo zygophylli*) on *Tetraena cornuta* (= *Zygophyllum cornutum*) and on *Tetraena prismatocarpa* (= *Zygophyllum prismatocarpum*). The description of a sixth species, *Uredo augeae* on *Augea capensis,* is added from literature.

Key words—Algeria, biodiversity, Egypt, Namibia, South Africa

Introduction

Up to now, five rust species producing uredinio- and/or teliospores have been described from representatives of the subfamily *Zygophylloideae*, four from Africa and one from Australia. Beier et al. (2003) revised the *Zyghophylloideae* and transferred most of the former *Zygophyllum* species from Africa into the genera *Roepera* and *Tetraena*. Thus, *Zygophyllum* in its new circumscription is no longer occurring in Africa.

During the course of a biodiversity study in the western parts of southern Africa, we collected four rust specimens on *Zygophylloideae*. These and herbarium specimens of the hitherto known African rusts on *Zygophylloideae* were examined. The nine investigated specimens belong to five rust species, three of which are new. The description of a sixth African rust species which we have not seen is added from literature.

Materials and methods

The following observations are based on collections made in South Africa by the first author between 02.IX.2002 and 30.IX.2002. These collections as well as specimens from herbaria were studied as we performed freehand sections and scrape mounts of infected plant material. The samples were heated in "Hoyer's fluid" (Cunningham 1972) and subsequently examined with a Carl Zeiss microscope equipped with bright field and phase contrast optics. Spore sizes are based on measurements of 50 spores of each occurring spore state. For scanning electron microscopy, air-dried fragments of rust infected leaves were put onto double-sided adhesive tape fixed to an observation stub, spattered with gold-palladium and observed with a Cambridge Stereoscan 250 Mk-2. In order to identify the rust fungi we checked several publications concerning the rust flora of Africa, which are available via internet under http://www.mycology.uni-tuebingen.de/databases/rust-literature/.

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* Part 217 in the series „Studies in Heterobasidiomycetes" from the Botanical Institute, University of Tübingen.

Results

The examined species are listed in alphabetical order. The following abbreviations are used: 0 = spermogonia = pycnia; I = aecia; II = uredinia; III = telia; IV = basidia.

Uromyces dinteri Mennicken, Maier & Oberw. sp. nov. (Fig. 1).

Anamorph. *Uredo zygophylli* Henn. non Jacz. (Hennings 1893): 113. Type on *Tetraena decumbens* (Delile) Beier & Thulin (= *Zygophyllum decumbens* Delile). Egypt, Majo, leg. Ehrenberg (B 70 0007286).

Pycnia et aecia ignota. Uredinia amphigena vel caulicola, subepidermalia, usque ad 0.5 mm diam., rubro-brunnea, mox nuda, pulverulenta. Urediniosporae subgloboideae, ovoideae vel ellipsoideae, 31–40 (–42) x (22–) 24–36 μm, pariete echinulato, 2.5–4 (–5) μm crasso, aureo-fusco, 6–9 poris germinationis dispersis. Telia amphigena vel caulicola, subepidermalia, usque ad 1 mm diam., atro-rubro-brunnea, mox nuda, compacta, pulverulenta. Teliosporae unicellulares, globoideae vel subgloboideae, bilaminatae, strato exteriore dilute aureo vel hyalino, usque ad 5 μm crasso, breviter echinulato, strato interiore castaneo, 5–8 μm crasso, (31–) 34–44 x 30–42 μm, poro germinationis apicali, pedicello hyalino, brevi.
In foliis caulisque cf. *Tetraenae* sp. (= *Zygophylli* sp.), *Zygophyllaceae*.

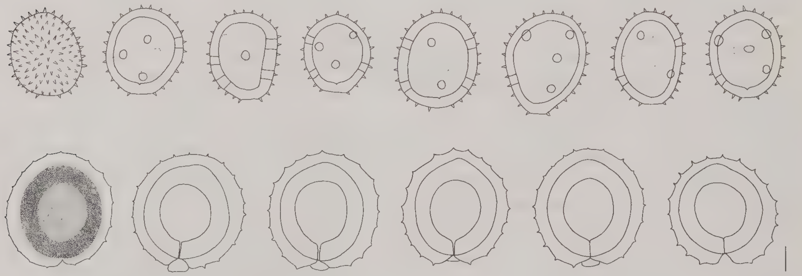


Fig. 1. *Uromyces dinteri* on cf. *Tetraena* sp. Uredinio- and teliospores. (Holotype K(M) 116414). Scale bar = 10 μm.

Pycnia and aecia unknown.

Uredinia amphigenous on leaves and on stems, subepidermal, scattered or arranged in groups, minute, round to ellipsoid, up to 0.5 mm wide, reddish-brown, exposed, pulverulent, surrounded by the torn epidermis. Urediniospores subgloboid, ovoid to ellipsoid, 31–40 (–42) x (22–) 24–36 μm, echinulate, spore wall uniformly about 2.5–4 (–5) μm thick, yellowish-brown, germ pores inconspicuous, 6 to 9, scattered, without papillae, but with cuneiform lucency of the spore wall.

Telia amphigenous on leaves and on stems, subepidermal, developing from the uredinia, scattered or arranged in groups, round, up to 1 mm wide, dark reddish-brown to black, exposed, compact, pulverulent, surrounded by the torn epidermis. Teliospores unicellular, globoid to subgloboid, rounded above and below, bilaminate, outer layer pale yellowish to hyaline, up to 5 μm thick, shortly echinulate, inner layer chestnut-brown, uniformly about 5–8 μm thick, up to circa 2 μm thicker in the range of the germ pore, smooth, size of spores (without hyaline outer layer) (31–) 34–44 x 30–42 μm, germ pore apical, partly with slightly brightened and yellowed papilla that is weakly developed, pedicel persistent or not, very short, thin-walled, hyaline. Most of the teliospores had germinated, so that the outer layer of the spore wall is laciniated and divided into patches, lacking pedicel and papilla. The inner layer of the spore wall is perforated in the area of the germ pore.
On the leaves of cf. *Tetraena* sp. (= *Zygophyllum* sp.), *Zygophyllaceae*.
Etymology. Named after the collector, Kurt Dinter (1868 – 1945), who was an important botanist in Namibia.

Specimens examined:

- On cf. *Tetraena* sp. (= *Zygophyllum* sp.). Namibia, Kalkfontein-Süd, near Karasberg, 29.VII.1923, leg. Kurt Dinter No. 4740, II III (Holotype K(M) 116414, Isotype B 70 0007285).
- On *Tetraena decumbens*. Egypt, Majo, leg. Ehrenberg, II (Type of *Uredo zygophylli* Henn., B 70 0007286).

The Namibian collection of *Uromyces dinteri* sp. nov. was erroneously labelled and/or determined as *Uromyces trollipi* (See below). The incorrect name was mentioned in Doidge (1927) and in Doidge (1950).

Uromyces namaqualandus Mennicken, Maier & Oberw. sp. nov. (Fig. 2).
Pycnia, aecia et uredinia ignota. Telia amphigena, subepidermalia, usque ad 2 mm diam., atro-brunnea vel nigra, mox nuda, compacta, pulverulenta. Teliosporae unicellulares, globoideae vel subgloboideae, bilaminatae, strato exteriore dilute aureo vel hyalino, lateraliter usque ad 8 μm crasso, apicaliter usque ad 3 μm crasso, grosse echinulato, strato interiore castaneo, lateraliter 5–8 μm crasso, apicaliter 4–10 μm crasso, 31–49 x 23–32 μm, poro germinationis apicali, annulliformi, pedicello hyalino, brevi, subinde usque ad 50 μm.
In foliis *Roeperae cordifoliae* (L.f.) Beier & Thulin (= *Zygophylli cordifolii* L.f.), *Zygophyllaceae*.

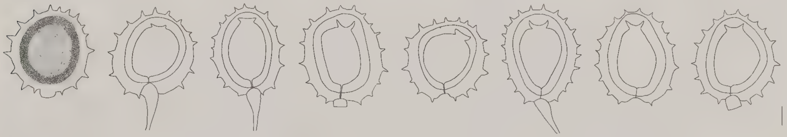


Fig. 2. *Uromyces namaqualandus* on *Roepera cordifolia*. Teliospores (Holotype RSA 147). Scale bar = 10 μm.

Pycnia, aecia, and uredinia unknown.
Telia amphigenous on leaves, subepidermal, separate, scattered or arranged in concentric groups up to 5 mm wide, single sori round, ellipsoid or oblong, up to 2 mm wide, dark chocolate-brown to black, without leaf spots surrounding telia, compact, early exposed, pulverulent, surrounded by the torn epidermis. Teliospores unicellular, globoid,

subgloboid to ellipsoid, ± rounded above and below, bilaminate, outer layer pale yellowish to hyaline, up to 8 μm thick at the sides, up to 3 μm thick at the apex, coarsely echinulate, inner layer chestnut-brown, about 2–5 μm thick at the sides, about 4–10 μm thick at the apex, smooth, size of spores (without hyaline outer layer) 31–49 x 23–32 μm, ring-shaped germ pore apical, without papilla, pedicel mostly persistent, normally broken immediately below the attachment, occasionally up to 50 μm long, thin-walled, collapsing, hyaline.

On the leaves of *Roepera cordifolia*, *Zygophyllaceae*.

Etymology. Named after the region of occurrence in South Africa, Namaqualand.

Specimens examined:

- On *Roepera cordifolia*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 31.0'', E 17° 33' 11.1'', 11.IX.2002, leg. M. Mennicken No. RSA 147, III (Holotype PREM, Isotype M).
- On cf. *Roepera* sp. South Africa, Northern Cape Province, Richtersveld, BIOTA-observatory at Yellow Dune, S 28° 36' 56.2'', E 16° 39' 22.2'', 14.IX.2002, leg. M. Mennicken No. RSA 157, III (Paratypes PREM, M).

Uromyces paulshoekensis Mennicken, Maier & Oberw. sp. nov. (Figs. 3–5)

Pycnia et aecia ignota. Uredinia amphigena, subepidermalia, usque ad 0.5 mm diam., cinnamomea, mox nuda, pulverulenta. Urediniosporae subgloboideae, ovoideae vel ellipsoideae, 27–38 (–44) x 22–28 μm, pariete supra basim echinulato, 2–3 μm crasso, aureo-fusco vel dilute castaneo, 3–6 poris germinationis dispersis. Telia amphigena, subepidermalia, usque ad 0.8 mm diam., atro-brunnea vel nigra, mox nuda, pulverulenta. Teliosporae unicellulares, globoideae, subgloboideae vel ellipsoideae, bilaminatae, strato exteriore dilute aureo vel hyalino, usque ad 3 μm crasso, breviter echinulato, strato interiore castaneo, lateraliter 2–4.5 μm crasso, apicaliter 3.5–5 μm crasso, 27–36 x 20–27 μm, poro germinationis apicali, pedicello hyalino, brevi, subinde usque ad 50 μm. In foliis cf. *Roeperae foetidae* (Schrad. & J.C. Wendl.) Beier & Thulin, *Zygophyllaceae*.

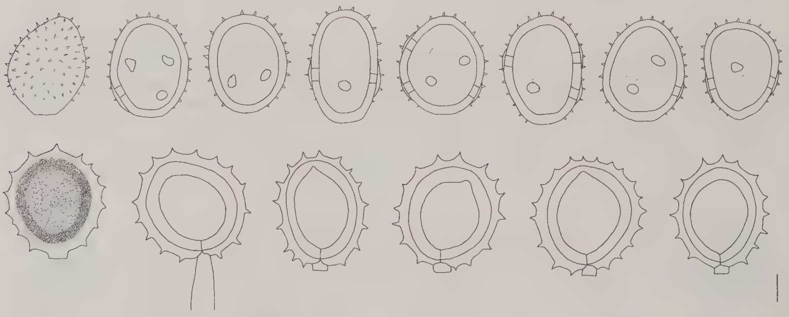
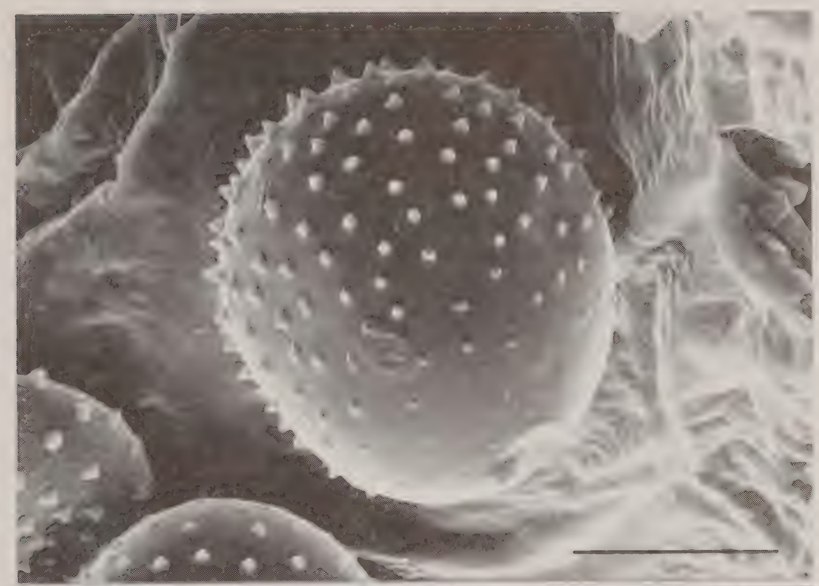


Fig. 3. *Uromyces paulshoekensis* on cf. *Roepera foetida*. Uredinio- and teliospores (Holotype RSA 133). Scale bar = 10 μm.

Pycnia and aecia unknown.

Uredinia amphigenous on leaves, subepidermal, separate or scattered, minute, round, up to 0.5 mm wide, cinnamon-brown, on slightly paler and yellowed leaf spots, early exposed, pulverulent, surrounded by the torn epidermis. Urediniospores subgloboid, ovoid to ellipsoid, borne singly on pedicels, 27–38 (–44) x 22–28 μm, echinulate, echinulation stronger pronounced at the apex, sometimes absent at the base, spore wall uniformly about 2–3 μm thick, yellowish-brown to pale chestnut-brown, germ pores



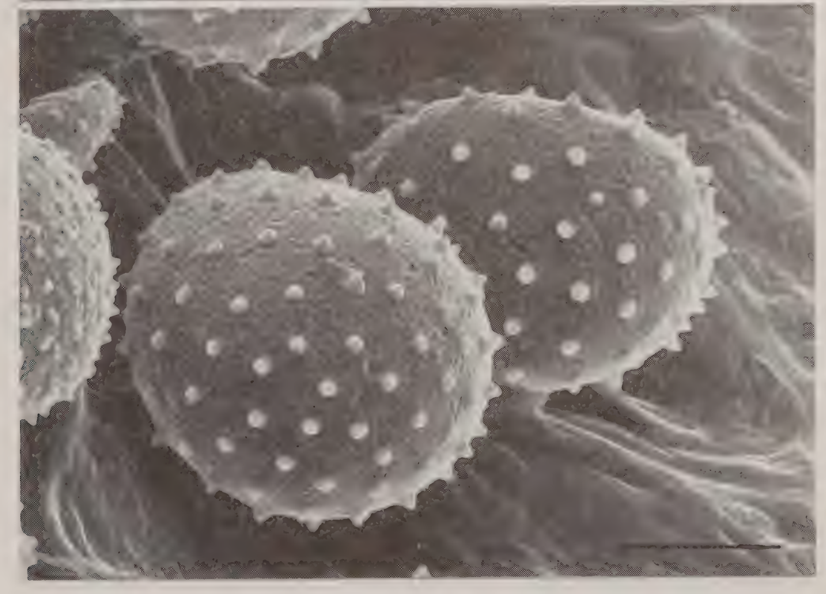


Fig. 4. *Uromyces paulshoekensis* on cf. *Roepera foetida*. Surface of a urediniospore (Holotype RSA 133). SEM. Scale bar = 10 μm. **Fig. 5.** *Uromyces paulshoekensis* on cf. *Roepera foetida*. Surface of two teliospores (Holotype RSA 133). SEM. Scale bar – 10 μm.

inconspicuous, 3 to 6, scattered, often irregularly in outline, with hyaline papillae that are weakly developed. Telia amphigenous on leaves, subepidermal, (partly) developing from the uredinia, separate or scattered, round, up to 0.8 mm wide, dark chocolate-brown to black, on slightly paler and yellowed leaf spots, early exposed, pulverulent, surrounded by the torn epidermis. Teliospores unicellular, globoid, subgloboid to ellipsoid, rounded above and below, bilaminate, outer layer pale yellowish to hyaline, up to 3 µm thick, coarsely echinulate, inner layer chestnut-brown, about 2–4.5 µm thick at the sides, about 3.5–5 µm thick at the apex, smooth, size of spores (without hyaline outer layer) 27–36 x 20–27 µm, germ pore apical, pedicel mostly persistent, very short, occasionally up to 50 µm long, thin-walled, hyaline.

On the leaves of cf. *Roepera foetida*, (recorded as *Zygophyllum* cf. *meyeri* Sond. which is according to Van Zyl (2000) (Beier, pers. comm.) synonymous to *Roepera foetida* (Schrad. & J.C. Wendl.) Beier & Thulin), *Zygophyllaceae*.

Etymology. Named after the neighbouring community in South Africa, Paulshoek.

Specimen examined:

- On cf. *Roepera foetida*. South Africa, Northern Cape Province, BIOTA-observatory at Leliefontein 624, S 30° 23' 22.4'', E 18° 16' 50.2'', 10.IX.2002, leg. M. Mennicken No. RSA 133, II III (Holotype PREM, Isotype M).

Uromyces trollipi Kalchbr. & MacOwan in Kalchbrenner (1882): 21. (Fig. 6)

Type on *Roepera foetida* (Schrad. & J.C. Wendl.) Beier & Thulin (= *Zygophyllum foetidum* Schrad. & J.C. Wendl.) (as *Hypophyllum foetidum* Schrad.). South Africa, Kagaberg, near Bedford, leg. Stud. Trollip, No. 1404 (K(M) 116415).

Syn. *Dichlamys trollipi* (Kalchbr. & MacOwan) Syd. & P. Syd. (Sydow & Sydow 1919): 105.

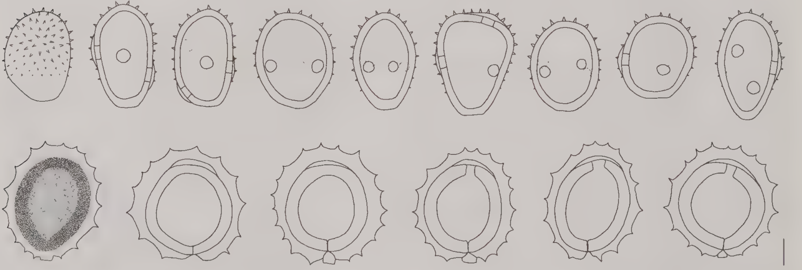


Fig. 6. *Uromyces trollipi* on *Roepera foetida*. Uredinio- and teliospores (Type K(M) 116415). Scale bar = 10 µm.

Pycnia and aecia unknown.

Uredinia amphigenous on leaves, separate, scattered or in irregular groups, minute, ± roundish, up to 0.7 mm wide, cinnamon-brown, on slightly paler leaf spots, early exposed, pulverulent, surrounded by the torn epidermis. Urediniospores subgloboid, ovoid, ellipsoid to oblong, often somewhat angular, borne singly on pedicels, 30–37 x 20–29 µm, echinulate, echinulation stronger pronounced at the apex, absent at the base, spore wall uniformly about 2–2.5 μm thick, yellowish-brown, germ pores conspicuous, 3 to 4, mostly ± equatorial, occasionally scattered, with hyaline papillae that are weakly developed.

Telia amphigenous on leaves, (partly) developing from the uredinia, separate or scattered, round, up to 0.7 mm wide, dark chocolate-brown to black, on slightly paler leaf spots, early exposed, compact to cushion-like, surrounded by the torn epidermis. Teliospores unicellular, globoid, subgloboid to ovoid, rounded above and below, bilaminate, outer layer hyaline, coarsely echinulate, inner layer chestnut-brown, about 3–5 μm thick at the sides, about 3–6 μm thick at the apex, size of spores (without hyaline outer layer) (31–) 33–39 (–43) x 24–32 μm, germ pore apical, with yellow papilla that is weakly developed, pedicel mostly persistent, very short, thin-walled, hyaline.

Specimen examined:

- On *Roepera foetida* (as *Hypophyllum foetidum* Schrad.). South Africa, Kagaberg, near Bedford, leg. Stud. Trollip No. 1404, II III (Type K(M) 116415).

The bilaminate character of the spore wall of the teliospores is cited in all available descriptions of *Uromyces trollipi* (Kalchbrenner 1882; Winter 1884; Sydow & Sydow 1919; Doidge 1927; Thirumalachar 1951). The conspicuous echinulation of the outer layer of the teliospores, which is also visible in water, in heated lactophenol, or in air, is not yet mentioned in literature. Doidge (1927) and Winter (1884) described the surface of the teliospores as verrucous. Sydow & Sydow (1919) characterized the outer layer as striped or as ridged. In the diagnosis (Kalchbrenner 1882) and in Thirumalachar (1951) no properties of the teliospore surface were mentioned.

Uredo augeae Pole-Evans (Pole Evans 1915): 115.

Type on *Augea capensis* Thunb., Namibia, Lüderitzbucht, XI.1912, leg. H. H. W. Pearson No. 8029 (Pole Evans No. 8409).

Syn. *Uredo augeae* Syd. & P. Syd. (Sydow & Sydow 1916): 259. Type on *Augea capensis*. Namibia, Lüderitzbucht, 1913, leg. A. Engler.

We have not seen this rust fungus. The description is adapted from Doidge (1927): "Sori amphigenous, not on leaf spots, scattered or arranged in circles, often sparsely and evenly covering the whole leaf surface, round, 0.5–1.5 mm. diam., long covered by the blistered epidermis, then surrounded by torn epidermis, chestnut brown. Spores subglobose, ellipsoid or ovoid, often more or less angular, yellow-brown to brown, 23–34 x 18–25 μ; epispore 2.5–3 μ thick, closely and minutely verruculose-echinulate, and with 6–8 scattered germ pores."

Uredo zygophyllina (Jacz.) Sacc. in Saccardo (1895): 223. (Fig. 7)

Syn. *Uredo zygophylli* Jacz. non Henn. (De Jaczewski 1893): 47. Type on *Tetraena cornuta* (Coss.) Beier & Thulin (= *Zygophyllum cornutum* Coss.). Algeria, Oued Biskra.

Pycnia, aecia, and telia unknown.

Uredinia amphigenous on leaves, subepidermal, separate, scattered, or arranged in concentric groups up to 3 mm wide, single sori round or ellipsoid, up to 1.5 mm wide, chocolate-brown, without leaf spots surrounding uredinia, early exposed, pulverulent, surrounded by the torn epidermis. Urediniospores globoid, subgloboid to ellipsoid, born singly on pedicels, 24–36 x 20–27 μm, coarsely echinulate, spore wall uniformly about 2.5–4 μm thick, yellowish-brown to pale chestnut-brown, germ pores inconspicuous 4 to 7, scattered, often without papillae, but with cuneiform lucency of the spore wall.

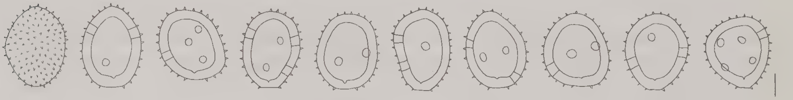


Fig. 7. *Uredo zygophyllina* on *Tetraena prismatocarpa*. Urediniospores (RSA 163). Scale bar = 10 μm.

Specimens examined:

- On *Tetraena cornuta*. Algeria, Biskra near Hammâm Salakin, IV.1901, leg. G. Schweinfurth, Vestergren Micromycetes rariores selecti No. 572, II (B 70 0007282).
- On *Tetraena prismatocarpa* (Sond.) Beier & Thulin (= *Zygophyllum prismatocarpum* Sond.) South Africa, Northern Cape Province, Richtersveld National Park, BIOTA-observatory at Koeroegapvlakte, S 28° 13' 47.2'', E 17° 01' 49.2'', 15.IX.2002, leg. M. Mennicken No. RSA 163, II (KSAN, PREM).

Sydow & Sydow (1924: 466) erroneously regarded *Uredo zygophylli* Henn. and *Uredo zygophyllina* (Jazc.) Sacc. as synonyms, although Saccardo in the diagnosis and Hennings (1901) observed some differences between both the rust fungi. As far as could be established *Uredo zygophyllina* is new to the rust flora of South Africa. *Tetraena prismatocarpa* seems to be a new host plant of *Uredo zygophyllina*.

In Table 1 a summary of the most important characters of the six known African rust species on *Zygophylloideae* is given.

We have not seen *Uromyces vesiculosus* G. Winter (Winter 1885: 22), which is known from several *Roepera* species (= *Zygophyllum*) in Australia (Shivas 1989; McAlpine 1906). According to McAlpine (1906) *Uromyces vesiculosus* has "densely warted, even prickly", thin-walled urediniospores "with 3 to 5 equatorial germ pores on one face, 26–35 x 19–24 μ, average 28 x 20 μ". The teliospores are "globose, elliptic, ovate or pear-shaped, thickened at the apex, rounded or with a broad apiculus more or less shortly conical, 21 μ diam., or 23–31 x 17–22 μ, average 25 x 20 μ; epispore thick, smooth, dark brown when mature; pedicel long, thick, persistent, may be flexuous, pale olivaceous, up to 150 μ". Thus, *Uromyces vesiculosus* differs markedly from all cited *Uromyces* species collected in Africa in having long persistent pedicels and especially in the absence of bilaminate teliospore cell walls. *Uromyces vesiculosus* differs from both of the *Uredo* species from Africa in having urediniospores with equatorial germ pores and thin-walled spore walls.

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Table 1. Schedule of characters of the rust species on *Zygophylloideae* (*Zygophyllaceae*) from Africa.
* Formerly known as *Zygophyllum*. [1] According to Doidge 1927.

Rust species	**Host genus**	**Urediniospores**					**Teliospores**			
							endospore			exospore
		measurement	germ pores		spore wall		measurement	spore wall		spore wall
		*µ*m	number	arrangement	*µ*m	echinulation	*µ*m	lateral *µ*m	apical *µ*m	thickness
Uromyces dinteri	*Tetraena* *	31–40(42) x (22)24–36	6 to 9	scattered	2.5–4(5)	± uniform	(31)34–44 x 30–42	5–8	5–8	± uniform
Uromyces namaqualandus	*Roepera* *	–	–	–	–	–	31–49 x 23–32	2–5	4–10	thinner at the apex
Uromyces paulshoekensis	cf. *Roepera* *	27–38(44) x 22–28	3 to 6	scattered	2–3	apically stronger pronounced, basally ± absent	27–36 x 20–27	2–4.5	3.5–5	thinner at the apex
Uromyces trollipi	*Roepera* *	30–37 x 20–29	3 to 4	± equatorial	2–2.5	apically stronger pronounced, basally absent	36–60 x 17–31(34)	3–5	3–6	± uniform
Uredo augeae [1]	*Augea*	23–34 x 18–25	6 to 8	scattered	2.5–3	?	–	–	–	–
Uredo zygophyllina	*Tetraena* *	24–36 x 20–27	4 to 7	scattered	2.5–4	± uniform	–	–	–	–

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A new species of *Curvularia* from Japan

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Abstract— A new fungal species, *Curvularia panici*, isolated from the leaves of *Panicum repens* collected in Japan, is described and illustrated as a species producing long conidia with more than six septa. Molecular phylogenetic analysis of the ITS regions and 5.8 S rDNA revealed that *C. panici* formed one genetic group with *Curvularia* distinguished from *Exserohilum* and long-conidia *Bipolaris*.

Key words— taxonomy, hyphomycetes, ITS

Introduction

Thirty-four species of the genus *Curvularia*, hyphomycetes, were described by Sivanesan (1987) and since then several new species of the genus have been described (Alcorn 1990, 1991, 1998, Morgan-Jones 1988, Sivanesan 1992). The morphological characteristics of *Curvularia* are similar to *Bipolaris* and *Exserohilum* in some species even if the teleomorphs are different (Sivanesan 1987, Tsuda & Ueyama 1985). Alcorn (1991) transferred *E. heteropogonicola* Sivan. to *C. heteropogonicola* (Sivan.) Alcorn and placed *E. paspali* J. J. Muchovej & Nesio as a synonym of *B. micropus* (Drechsler) Shoemaker. However, the three genera, *Curvularia*, *Bipolaris* and *Exserohilum*, could be separated by conidiophores and conidia (Sivanesan 1987, Alcorn 1988). Recently, molecular phylogenetic analyses showed that *Bipolaris* and *Curvularia* formed a different phylogenetic clade from *Exserohilum*, and *Bipolaris* was closely related to *Curvularia* (Berbee et al. 1999; Olivier et al. 2000). In this study, an additional new species is described and illustrated, based on its distinctive conidial morphology. Molecular phylogenetic analysis was carried out on the ITS regions and 5.8 S rDNA.

Materials and Methods

Leaf samples of *Panicum repens* L. (torpedograss) with brown spindle-shaped lesions of approximately 2.5 mm in length were collected in July 2000 at Nago, Okinawa Pref., the most southern region of Japan. A single spore produced on the surface-sterilized leaf was transferred to tap water agar with autoclaved wheat straw (TWA+wheat straw) plates and exposed to nuv light on a 12 h diurnal cycle at room temperature (25°C). The morphological descriptions are based on 10-14 days old cultures.

The scanning electron microscope (SEM) photographs were taken according to Chung et al. (2004).

For molecular analysis, whole genomic DNA was extracted from the mycelium of the isolate grown on V8 juice agar by homogenizing it in a standard SDS detergent lysis buffer, followed by a phenol/chloroform extraction and precipitation in ethanol with sodium acetate (Sambrook et al. 1989). The complete ITS regions and 5.8 S rDNA were amplified using a primer pair of ITS1 and ITS4 (White et al. 1990). The PCR conditions were one cycle for two min at 95°C, 35 cycles for 30 sec at 95°C, 30 sec at 55°C, two min at 72°C, and a final cycle at 72°C for five min. PCR products were first purified by Wizard® PCR Preps DNA Purification System (Promega). Purified PCR products were reacted with BigDye Terminator v3.1 Cycle Sequencing Kit (Applied Biosystems) and then analyzed by ABI PRISM 3100. For phylogenic comparison, the GenBank sequences of seven species of *Exserohilum*, nine of *Cochliobolus*, four of *Bipolaris*, nine of *Curvularia* and *Fusarium oxysporum* as the outgroup were also included in the analysis (Fig. 2). The DNA sequences were aligned using Clustal X v1.8 (Thompson et al. 1997). Phylogenetic analyses of the data were done by distance methods. The distance matrix for the aligned sequences was calculated using Kimura's two-parameter method (Kimura 1980) and was analyzed with the neighbor-joining (NJ) method using the program PAUP* 4.0 beta 10 (Swofford 2002). Bootstrap values were generated with 1000 replicate heuristic searches to estimate support for clade stability of the consensus tree using the same program.

Taxonomic Description

Curvularia panici W. H. Chung & Tsukib., *sp. nov.* FIGURE 1

Coloniae (in agaro aquoso et caulibus triticorum) cinereae ad brunneas, floccosae. Mycelium ex hyphis ramosis septatis pallide brunneis laevibus 2-4.8 μm crassis constans. Stromata absentia. Conidiophora cylindracea, simplicia, raro ramosa, erecta vel flexuosa, supra geniculata, septata, laevia vel verruculosa, pallide brunnea vel brunnea, ad 200 μm longa, 3-5.5 μm lata; nodi conidiogeni laeves. Conidia 47-113 × 10-17 μm, recta vel curvata, plerumque valde curvata, pallide brunnea vel brunnea, fusiformia, (4-) 5-10 (-12) distoseptata; cellulae mediarum et basalium verrucosae; cellulae terminalium subhyalinae vel pallide brunneae; hilum truncatum; cellulae tumidae in cellulis germinalibus aliquando adsunt.

Habitat: in foliis *Panici repensi*

Holotypus: NIAES 20550, cultura sicca, isolata e foliis morbo attectis *Panici repensi*, Nago, Okinawa in Japonia, 8 July 2000, T. Tsukiboshi, in Herbario Instituti Nationalis Agro-Environmentalis Scientiae, Tsukuba, Japonia.

Colonies in 'TWA+wheat straw' agar grey to brown, floccose. Mycelium composed of branched, septate, pale brown, smooth, 2-4.8 μm thick hyphae. Stromata not formed. Conidiophores cylindrical, simple or rarely branched, erect to flexuous, geniculate above, septate, smooth to verruculose, pale brown to brown, variable in length, up to 200 μm long and 3-5.5 μm wide, conidiogenous nodes smooth. Conidia 47-113×10-17 μm in size, straight to curved, often strongly curved, pale brown to brown, fusiform, (4-)5-10(-12) distoseptate, verrucose in the middle and basal cells, end cells subhyaline

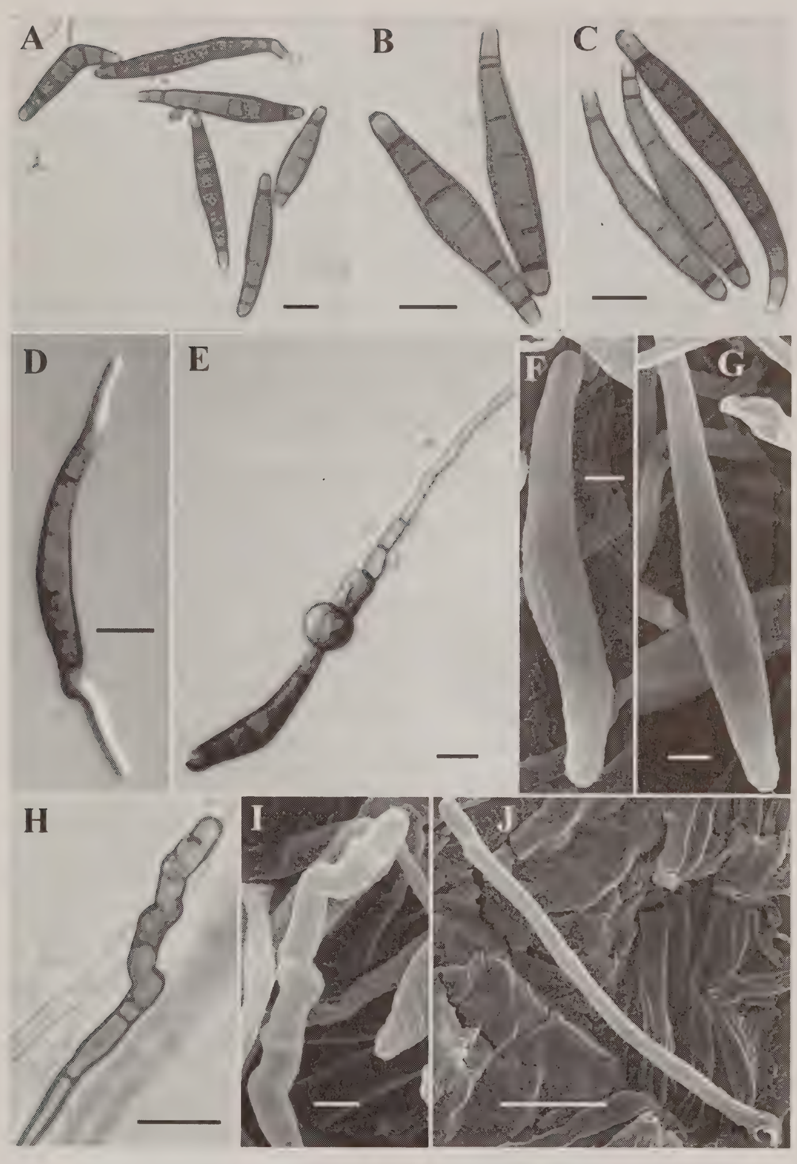

Fig 1. *Curvularia panici*. **A-C.** Conidia; **D-E.** Germinated conidia; **F-G.** SEM showing conidia; **H-J.** Conidiophores. Scale bars Fig. 1A-E=20μm; Fig. 1F-G=5μm; Fig. 1H=20μm, Fig. 1I=4μm, 1J=50μm

to pale brown, indistinctly protruding truncate hilum, swollen cells sometime in germinated cells.

KEY CHARACTERS — The conidiophores are cylindrical, simple or rarely branched. The conidiophores are septate, straight to flexuous, geniculate above and cicatrized (Fig. 1H, I). The surface of conidiophores is smooth or verrucose on the basal part and conidiogenous nodes are smooth (Fig. 1I, J). Conidia are straight to curved and the central cells are usually broader than the other cells (Fig. 1A, B, C). The flush hilum on the basal cell appears slightly protuberant. The surface of the middle and basal cells is verrucose (Fig. 1F, G). The conidia germinate principally from one or both end cells and the basal germ tube originated close to the hilum and grew semiaxially (Fig. 1D, E). Conidia are almost all more than 6-septated. A globose thin-walled vesicle is occasionally formed at the end cell during germination (Fig. 1E). The wall color is light brown to brown and both end cells are paler than the other cells (Fig. 1A, B, C). *C. panici* is similar to *C. heteropogonicola* and *C. oryzae-sativae* in conidial morphology, but the conidia of *C. panici* are much longer and more curved.

Phylogenetic Analysis and Discussion

Upon comparison with all ITS regions and 5.8 S rDNA sequences included in this study and available in databases, *C. panici* (GenBanK: AB164703) formed a group with the genus *Curvularia* that included the short-conidia *Bipolaris* group to which belongs *Co: hawaiiensis* (Fig. 2). According to the NJ tree, it was genetically closely related to *C. inaequalis*. On the other hand, *Curvularia* spp. formed a different group from the long-conidia *Bipolaris* group that includes *B. zeae* (Berbee et al. 1999), with a 72% bootstrap value. The long-conidia *Bipolaris* spp. formed a monophylogenetic group, with a 100% bootstrap value. Moreover, the *Curvularia* group was more related to the long-conidia *Bipolaris* than to *Exserohilum*. The result revealed that the new species was significantly distant from the long-conidia *Bipolaris* spp. and *Exserohilum*. Sivanesan (1987) and Alcorn (1988) reported the conidia of *Curvularia* spp. mainly had a short, curved, swollen middle cell and most had less than 4-distoseptae. In this study, *C. panici* produced long conidia with more than 6-distosepta, a morphology that had not been reported for *Curvularia*. However, both ends of the conidia were curved and pale and conidiophores were geniculate, characteristics that are typical of *Curvularia* (Fig. 1). Moreover, the molecular phylogeny revealed that *C. panici* was closely related to other *Curvularia* spp. Although the conidial morphology is somewhat similar to *Exserohilum*, the phylogeny revealed that *C. panici* is distant from *Exserohilum* and provided strong support that this species does not belong to *Exserohilum*. Thus, we suggest that the description of *Curvularia* should be revised based on our species description of *C. panici*.

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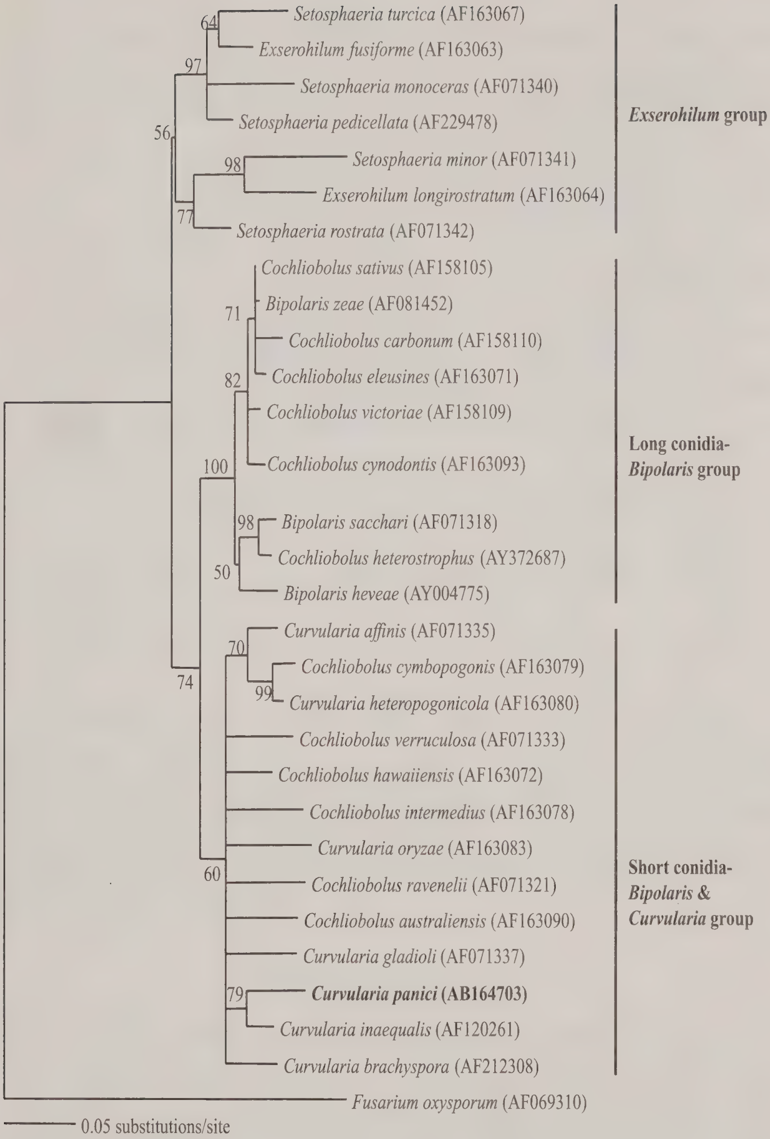
64
Setosphaeria turcica (AF163067)
Exserohilum fusiforme (AF163063)
97
Setosphaeria monoceras (AF071340)
56
Setosphaeria pedicellata (AF229478)
98
Setosphaeria minor (AF071341)
Exserohilum longirostratum (AF163064)
77
Setosphaeria rostrata (AF071342)
Exserohilum group
Cochliobolus sativus (AF158105)
71
Bipolaris zeae (AF081452)
Cochliobolus carbonum (AF158110)
82
Cochliobolus eleusines (AF163071)
Cochliobolus victoriae (AF158109)
100
Cochliobolus cynodontis (AF163093)
Long conidia-Bipolaris group
98
Bipolaris sacchari (AF071318)
50
Cochliobolus heterostrophus (AY372687)
Bipolaris heveae (AY004775)
70
Curvularia affinis (AF071335)
Cochliobolus cymbopogonis (AF163079)
74
99
Curvularia heteropogonicola (AF163080)
Cochliobolus verruculosa (AF071333)
Cochliobolus hawaiiensis (AF163072)
Cochliobolus intermedius (AF163078)
Curvularia oryzae (AF163083)
60
Cochliobolus ravenelii (AF071321)
Short conidia-Bipolaris & Curvularia group
Cochliobolus australiensis (AF163090)
Curvularia gladioli (AF071337)
79
Curvularia panici (AB164703)
Curvularia inaequalis (AF120261)
Curvularia brachyspora (AF212308)
Fusarium oxysporum (AF069310)
0.05 substitutions/site

Fig 2. A neighbor-joining tree inferred from the ITS regions and 5.8 S rDNA sequences from 31 taxa. Numbers in the front of branches showed bootstrap values in 1000 bootstrap replicates. Boldfaced taxon is *Curvularia panici* (AF164703). Length of branches is proportional to number of base changes, indicated by the scale bar.

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A new species of *Mollisia* on *Solanum dulcamara* from Lithuania

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Abstract–*Mollisia solani*, collected on dead stems of *Solanum dulcamara* in Viešvilė Strict Nature Reserve, Lithuania, is illustrated and described as a new species.

Key Words–Ascomycetes, *Dermateaceae*, taxonomy, herbicolous

Introduction

Investigations on discomycetes in Viešvilė Strict Nature Reserve, Lithuania were carried on in 1999-2002. Extensive material was collected in various habitats. Previous results have been published in two papers (Kutorga 2002, Kutorga & Raitviir 2003). Among collected specimens a mollisioid fungus fruiting on dead stems of *Solanum dulcamara* has come to our special attention. It has an uncommon anatomical structure. The surface cells of apothecium are encrusted with thick yellow-brown resinous matter. This fungus is described below as a new species.

Material and Methods

Dried material was studied by both authors. Freehand sections made with a razor blade and also squashed materials were mounted in tap water, 5% aqueous KOH, Melzer's reagent (MLZ), Lugol solution (LUG), Cotton Blue (CB) in Lactic acid and Lactic acid for microscopic examination. Line-drawings of microscopical structures were made using prints obtained with a Nikon Coolpix 4500 digital camera mounted on an Olympus CH-40 microscope and also using a Nikon Labophot-2 microscope equipped with a drawing-tube. The material is deposited in the Herbaria of the Institute of Botany, Vilnius (BILAS) and Institute of Zoology and Botany, Tartu (TAA).

Taxonomic Description

Mollisia solani Kutorga & Raitv. *sp. nov.* FIGURE 1

Apothecia dispersa usque ad gregaria, primo globosa dein patellata, substipitata, ut videtur late sessilia, 0.2-1.2 mm in diametro, extus ochracea basi brunnea, disco pallide griseo. Excipulum ectale ex textura globulosa compositum, cellulis luteis vel hyalinis, in stratibus externis ponderoso luteo-brunneo resinoso incrustatum. Asci uncinati, cylindraceo-clavati, octospori, 34-43 × 4.5-5 μm, poro iodo caerulescentia praediti. Sporae fusoideo-clavatae, rectae, inequilateralia, subinde minute curvatae, interdum biguttulatae, hyalinae, (7-)8-9.5 × 1.5-2 μm. Paraphyses cylindraceae, 1.5 μm in diametro, apicibus subclavatis. Ad caules emortuarum Solani dulcamarae crescit.

Etymology: from a host plant generic Latin name *Solanum.*

Apothecia scattered to gregarious, superficial, often developing in the cracks or under detached pieces of the host stem cortex, at first globose, later discoid, nearly sessile (substipitate), seated on a circular and minutely elevated base, finally expanded and saucer shaped. **Disc** 0.2-1.2 mm in diameter, circular or nearly circular in outline, concave, flat to slightly convex, translucent, light greyish in the center and slightly pinkish/rose-coloured towards the margin when fresh; circular, triangular to irregular, shallow concave, greyish to ochraceous when dry, in mature specimens sometimes slightly mealy. **Margin** even, light coloured when fresh, occasionally becoming whitish on drying. **Receptacle** smooth, light ochraceous at flanks, becoming brown towards the basal part, bearing brownish anchoring hyphae on the flanks and around the base in fully mature apothecia. **Excipulum** composed of two distinct layers. Ectal excipulum 40-50 μm thick at central part, thinner towards the margin, of *textura globulosa*, individual cells more or less isodiametrical, mostly polygonal due to pressure of intercellular matter, thin- to thick-walled (0.5-1 μm), yellowish (outer sublayer) to hyaline (inner sublayer), peridial (outermost) cells smaller, 5-8 μm in diameter, inner cells wider, 8-15(-24) μm in diameter, becoming more elongated towards the margin, and then 12-14 × 7-9 μm. Medullary excipulum 15-20 μm tall at central part, thinner towards the margin, of *textura oblita-porrecta*, individual cells hyaline, elongated, 10-14 × 2-4 μm, thin-walled and probably gelatinised. Marginal cells clavate, 10-15 × 3-4 μm, hyaline. Surface of ectal excipulum heavily encrusted with 1-2.5 μm thick layer of yellow-brown resinous matter. Crust-like exudate mainly concentrated along neighbouring walls of excipular cells and best observed in sections mounted in water. Other mounting media, especially KOH or Lactic acid, partly dissolve the exudation. **Stipe-like base** within the substratum, ca. 15 μm high, 100-120 μm in diameter, composed of more or less isodiametric cells, 5-10 μm in diameter, with thin, yellowish to hyaline cells. Anchoring and substratal hyphae 2-4 μm thick, branched, septate, with brown walls.

Asci arising from croziers, cylindric-clavate, with narrowed and usually conical apex, 8-spored, 34-43 × 4.5-5 μm, apical pore euamyloid (staining blue in LUG and MLZ without or with KOH pre-treatment). **Ascospores** biseriate to irregularly arranged, fusiform-clavate, mostly straight, occasionally slightly curved, often inequilateral, occasionally containing two small polar guttules (observed in KOH), aseptate, smooth, hyaline, (7-)8-9.5 × 1.5-2 μm, spore plasma staining blue in CB. **Paraphyses** cylindrical,

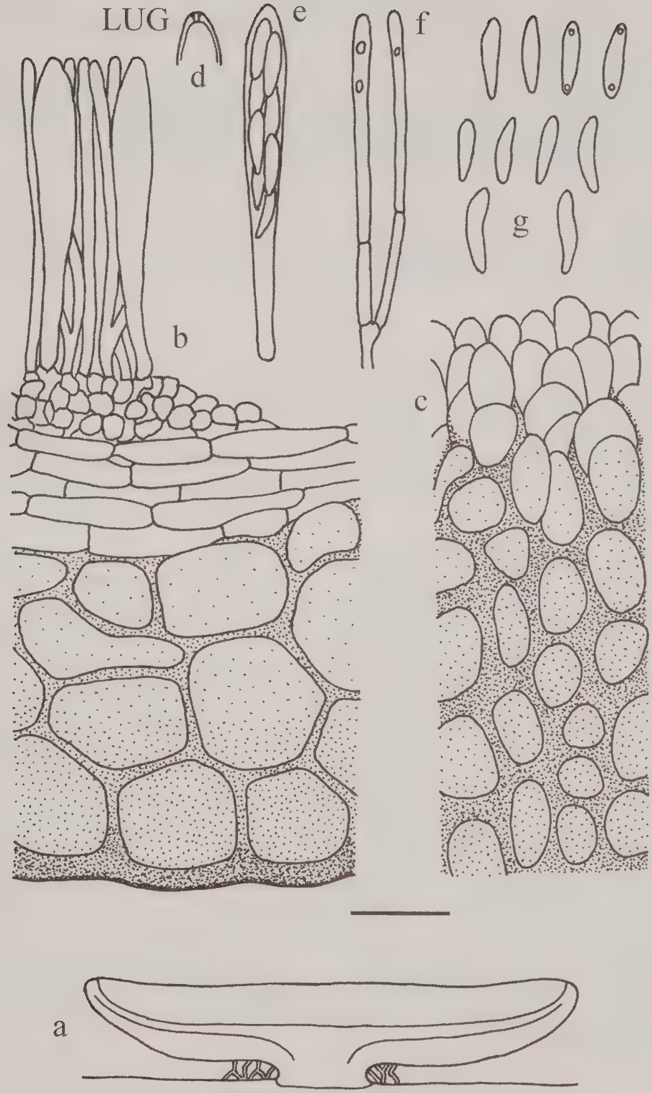

Fig. 1. *Mollisia solani*, scale 10 μm, except for apothecium (a) 100 μm. a, vertical section of apothecium; b, vertical section of hymenium and excipulum on lower flank; c, surface view of excipulum from outside; d, apex of ascus in LUG, with euamyloid apical ring; e, mature ascus with ascospores; f, paraphyses; g, ascospores

branched in lower part, 1.5 μm wide, slightly enlarged at the apices, obtuse, hyaline, not or slightly exceeding the asci, remains of inclusions present in rehydrated material.

Anamorph not observed.

Ecology, and Range – Saprotroph on moist dead stems of previous year's growth of *Solanum dulcamara* in water-fringing reed beds with tall helophytes (*Phragmites australis*, *Typha latifolia*, *Sium latifolium*, *Thelypteris palustris*) growing on peat soil of the bank of a mesotrophic lake. So far only known from one collection.

> **SPECIMENS EXAMINED** – LITHUANIA: **Tauragė district**, Viešvilė Strict Nature Reserve, forest area No 70, on the bank of Glitis lake, on dead stems of *Solanum dulcamara* L., 27.IX.2000, E. Kutorga (**HOLOTYPE** – BILAS-*25215*, ISOTYPE – TAA-*182350*).

Discussion

There is a great number of herbicolous species described in *Mollisia* (Fr.) P. Karst. and *Pyrenopeziza* Fuckel, which have been introduced largely on the basis of host connection. As far as we have been able to establish, none has been described from species of *Solanum*. This species belongs surely to *Mollisia*, considering its comparatively light-coloured saucer-shaped (when fully mature) apothecia with a very short stipe immersed into the substrate.

An outstanding feature of it is, however, its ectal excipulum encrusted with yellowish brown amorphous matter, which is present in intercellular spaces and covers the outermost layer of cells as an irregular crust. Because of this crust *M. solani* can be confused with the members of *Crustomollisia* Svrček and *Micropeziza* Fuckel. In these two genera, however, the amorphous, brownish particles are embedded in very thin gelatinous layer which covers the ectal excipulum and there is no amorphous matter in intercellular spaces. In *Crustomollisia*, e.g. *C. roburnea* (Velen.) Svrček described and illustrated by Svrček (1987) and by H.O. Baral (in H.O. & O. Baral & Marson: In Vivo Veritas. 2nd ed. 2 CDs, April 2003) as *Calycellina castanea* (Sacc. & Ellis) Dennis, these exudates form irregularly shaped yellow-brown to red-brown crusts. *C. castanea* differs from specimens studied and other mollisioid species in its markedly swollen tips of paraphyses embedded in gel and with an oily vacuole inside and by an excipulum of *textura prismatica*. Also the species of *Micropeziza* have wide paraphysis tips embedded in gel and apothecia develop under a shield.

The encrustation of surface cells is not yet reported in the genus *Mollisia*. Gminder (1996), however, reported the presence of intercellular gel in the ectal excipulum of *M. rosae* (Pers.) P. Karst. and *M. prunicola* (Fuckel) Gminder, Baral & E. Weber in his study of living material.

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Revision of the taxonomic position of the Phoenix Mushroom

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Abstract—The Phoenix Mushroom, previously assigned to *Pleurotus sajor-caju* (=*Lentinus sajor-caju*), is an important edible mushroom widely cultivated with a great commercial value, but confusion on its taxonomic position and scientific name have occurred since it was first isolated for cultivation. In the present study, both morphological and molecular data were gathered from strains commonly cultivated in China and from various collections of the same fungus. The absence of the annulus on the stipe and of the hyphal pegs on the hymenophoral trama, coupled with the larger basidiospores (7.0–10.5 × 3.0–4.5 μm), distinguish the Phoenix Mushroom from *L. sajor-caju*. The smaller (6.0–10.5 cm) and light coloured pileus with excentric to lateral stipe and faster fruiting rates of the Phoenix Mushroom showed a close affinity with *P. pulmonarius*. Strains of the Phoenix Mushroom share a very similar or identical ITS sequence with other collections from the field, which is different from those of *P. ostreatus*, a morphologically close related species. It is concluded here that the strains named Phoenix Mushroom are *P. pulmonarius*, based on both morphology and molecular studies.

Key words— Basidiomycetes, oyster mushroom, *Pleurotaceae*

Introduction

In 1978, a fungal strain named the Phoenix Mushroom (also assigned to *Pleurotus sajor-caju* (Fr.) Singer) was introduced into China by Prof. S. T. Chang of the Chinese University of Hong Kong (Mao, 1996). Since then the fungus has been widely cultivated in China (Huang, 1993; Mao, 1996). The strain was originally obtained from the foot hills of Himalayas (Jandaik & Kapoor, 1976b) and numbered as ITCCF 1725 (Kurtzman & Zadražil, 1984). Later, the culture was deposited at the American Type Collection (ATCC), accessioned as ATCC 32078 (Roxon & Jong, 1977; as ATCC 32978 in Kurtzman & Zadražil, 1984, and ATCC 39278 in Zhu, 1983). The common name, Phoenix Mushroom (Feng-Wei-Gu in Chinese), was also given by Prof. Chang, referring to the phoenix graph in the logo of the University of Hong Kong, which resembles to the basidioma of the fungus (Mao, 1996).

The Phoenix Mushroom is considered nutritious (Jandaik & Kapoor, 1975) and has been cultivated for commercial production. However, the yield of mushrooms of the fungus was not high (Jandaik, 1974) and not widely cultivated. Prof. Chang obtained an isolate of the fungus from Dr. Z. Bano of Central Food Technological Research

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Institute, Mysore, India (Zhu, 1983). Owing to the physiological study of the fungus and the improvement of cultivation techniques by both Prof. Chang and Dr. J.-Y. Cao of Sidney University, Australia, the Phoenix Mushroom was accepted by many mushroom growers and widely spread (Zhu, 1983). The most recent statistics shows a production of 909,000 metric tons of the fungus worldwide every year, mostly in the Mainland China (Chen, 2004: http://danr.ucop.edu/ihrmp/oak34.htm). This is a common mushroom widely cultivated in many provinces of China, e.g. Fujian (Zeng, 1999), Guangdong (Bi et al., 1990; Huang, 1993; Zeng, 1999), Hong Kong (Chang & Mao, 1995), Xizang (Zeng, 1999), and so on.

The Latin name, *P. sajor-caju* was used to refer to the Phoenix Mushroom in the very beginning of the isolate of the fungus and has been adopted in many articles and in commercial catalogues. However, *P. sajor-caju* was originally described and illustrated in *Agaricus* L. by Rumpf (1750) and sanctioned by Fries (1821), who then transferred it to *Lentinus* Fr. (Fries, 1838). Singer (1951) considered it to be a member of *Pleurotus* (Fr.) P. Kumm., but it is currently accepted by many authors as *L. sajor-caju* (Fr.) Fr. (e.g. Teng, 1963; Corner, 1981; Hilber, 1982; Pegler, 1983; Bi et al., 1990, 1997; Pegler & Yao, 1995; Mossebo, 2002). The earliest use of the name *P. sajor-caju* for the Phoenix Mushroom in the Mainland China appeared in 1981 by Lin *et al.* (1981) reporting the indoor cultivation of the fungus on straw. Since then, with the widespread of the fungus in China, the Phoenix Mushroom had been linked with *P.* (*L.*) *sajor-caju* in various reports (e.g. Wu & Xiang, 1983; Huang, 1993; Shao & Xiang, 1997) and the Latin name is still used for the fungus by some authors (e.g. Zeng, 1999; Chen & Gao, 2002; Chen, 2004: as above). Yao (1995) followed the Chinese literature and proposed to use the Chinese phrase for the Phoenix Mushroom (Feng-Wei-Gu) as the epithet of Chinese scientific name for *L. sajor-caju* (=*P. sajor-caju*).

The differences between the commercial *P. sajor-saju* and the true *P.* (*L.*) *sajor-caju* in the pileal colour, spore size, hyphal system and subhymenium were noticed by Hilber (1982). Based on morphology and incompatibility relationships, Hilber (1982) thought that the commercial *P. sajor-cajus* was possibly *P. pulmonarius* (Fr.) Quél.. Kurtzman & Zadražil (1984) also cast their doubt on the identity of the Phoenix Mushroom. They reported that a veil or an annulus was never observed in any of the numerous mushrooms grown from the strain ITCCF 1725 and that these structures were not found in the mushroom photographs published by Jandaik & Kapoor (1976c) for ITCCF 1725. In addition, Kurtzman & Zadražil (1984) also had the information from Madam Quimio that the mushrooms from an isolate (# 495) of *P. sajor-caju* [*sic*], whose identity was confirmed by Dr Pegler, did not look like the Phoenix Mushroom pictures of Jandaik & Kapoor (1976c) and that cultures of both the strains on agar appeared different as well. The resemblance of basidiomata of ATCC 32078 to those of *P. pulmonarius* was observed by Zervakis & Balis (1991). Pegler & Yao (1995) discussed the distinction between *L. sajor-caju* and *P. ostreatus* (Jacq.) Quél., indicating these two fungi belonging to different genera. In China, suspicion of the identification of the strains called the Phoenix Mushroom was first raised by Huang (1982), who pointed out the morphological differences between the Phoenix Mushroom and the description of *L. sajor-caju* by Teng (1963). The suspicion was also raised by Mao *et al.* (1993), Mao (1996, 1998) and Bi *et al.* (1997). They expressed their doubt on that the so-called Phoenix Mushroom is not *L. sajor-caju*. The Phoenix Mushroom was further linked to

P. pulmonarius by Huang (1998, 2000) and Tolgor & Li (2001), but no research report was made.

To resolve the confusion of names occurred in both the literature and the edible mushroom market and to ensure the correct use of fungal names, the cultivated Phoenix Mushroom was studied. Both morphological characters and molecular data were gathered to clarify the identity of the fungus.

Materials and Methods

Fungal materials

Three strains of the Phoenix Mushroom commonly cultivated in China and deposited as *P. sajor-caju* in the China General Microbiological Culture Collection Center, Beijing, China (CGMCC) were examined, i.e. AS 5.353 (=ATCC 32078), AS 5.412 and AS 5.593. The strains were subcultured in 100 ml flasks containing 40 ml potato dextrose broth in the dark at room temperature for two weeks, gently shaken by hand twice a day at 12 h intervals. The mycelium was harvested and dried at 65°C for molecular work. All the strains were also cultivated in a mushroom farm on a substrate containing cottonseed shell, broadleaf sawdust, wheat bran and lime. For comparison, four strains of *P. ostreatus* were cultivated under the same conditions. The basidiomata were collected as voucher specimens and deposited in the Mycological Herbarium, Academia Sinica (HMAS), with the accession numbers of HMAS 89518, HMAS 86407 and HMAS 86396, respectively. Other collections named as *P. pulmonarius*, *P. sajor-caju* (or *L. sajor-caju*) and *P. ostreatus* housed in HMAS, HKAS (Herbarium of Kunming, Academy Sinica), F (National Museum of Natural Science, Taiwan) and VTMH (Massey Herbarium, Virginia Polytechnic Institute and State University, USA) were also examined. For comparison, materials from other counties, the representative specimen of *P. pulmonarius* (TENN 50539, Petersen & Hughes, 1993) and the epitype of *P. ostreatus* (TENN53662A, Petersen & Krisai-Greilhuber, 1996) were studied. Materials of other species of *Pleurotus*, *P. citrinopileatus* Singer, *P. cystidiosus* O. K. Mill., *P. calyptratus* (Lindblad) Sacc. and *P. eryngii* (DC.) Gillet were also included for DNA sequencing (see Table 1).

Morphological observation

Sections from the basidiomata were cut by hand and mounted in 5% KOH. Optical microscopy studies were carried out at 400 and 1000 magnitudes. Size ranges of basidiospores, basidia and cheilocystidia were based on ocular micrometer measurements.

Molecular study

Samples of 20–30 mg dried materials from the culture and basidiomata were ground and transferred to a sterile 1.5 ml Eppendorf tube. About 600 μl preheated nuclei lysis buffer containing 0.2 M Tris, 0.05 M EDTA, pH 7.5, 2.0 M NaCl and 2% CTAB (hexadecyltrim ethylammonium bromide) was added to each sample. Tubes were vortexed then incubated at 65°C for 30–60 min. One volume of chloroform: isoamylol (24:1) was added and mixed by inverting tubes for 10 min. After centrifugation at 13,000 rpm for 10 min., the aqueous phase was transferred to a new tube and the chloroform extraction repeated. DNA was precipitated overnight at –20ºC by adding 0.1 volumes of 3.0 M sodium acetate, pH 5.2, and two volumes of cold 100% ethanol. Pellets were collected by centrifugation at 13,000 rpm for 20 min., washed with cold 70% ethanol then dried at room temperature. DNA was resuspended in 30–100 μl TE (pH 8.0, in 1/80 dilution). The raw DNA was then diluted 10–1000 folds in water before being used for PCR amplification.

Amplification of ITS was performed by using the primer pair ITS5/4 (White et al., 1990). The total reaction volume of 25 μl contained 3 mM $MgCl_2$, 0.1 μM each primer, 0.2 mM each dNTP, 2 units of Promega *Taq* polymerase, 1 μl template DNA and buffer as provided by Promega. The reactions were placed in a GeneAmp® 9700 thermal cycler under the following temperature regime: initial denaturation at 95°C for 1 min, followed by 30 cycles of denaturation at 95°C for 30 s, annealing at 50°C for 30 s, and extension at 72°C for 45 s, then a final extension at 72°C for 7 min. PCR products were purified with a QIAquick PCR purification system (Qiagen), following manufacturer's directions and sequenced using ABI PRISM Big Dye Terminator Cycle Sequencing Ready Reaction Kit on ABI Prism® 3100 Genetic Analyzer (Applied Biosystems, Foster City, Calif.).

Table 1. ***Pleurotus*** taxa sampled for DNA analysis

Taxa	Specimen or culture #[a]	Origin	GenBank accession #	References
P. abieticola R.H. Petersen & K.W. Hughes	TENN 52358	Russia	U59326	Petersen & Hughes 1997
	6554/TENN 52359[b]	Russia	AY450348	Petersen & Hughes 1997
P. albidus (Berk.) Pegler	Duke 327	Brazil	AF345658	Albertó et al. 2002
	TENN 57623	Costa Rica	AF345661	Albertó et al. 2002
P. australis (Cooke & Massee) Sacc.	CBS 100127	Unkown	AY265812	Choi et al., direct submission
	NZPR-215[b]	Australia	AY450342	Hughes & Petersen, direct submission
P. calyptratus (Lindblad) Sacc.	HMAS 63355	Hebei, China	AY562495	New submission
P. citrinopileatus Singer	ASI 2011	Unkown	AY265852	Choi et al., direct submission
	HMAS 63344	Jilin, China	AY696301	New submission
P. cornucopiae (Paulet) Rolland	8763[b]	Austria	AY450341	Hughes & Petersen, direct submission
P. cystidiosus O. K. Mill.	S037	Taiwan	AY540320	New submission
	ASI 2079	Unkown	AY368655	Choi et al., direct submission
P. djamor (Rumph. ex Fr.) Boedijn	CBS 100134	Unkown	AY265821	Choi et al., direct submission
P. eryngii (DC.) Gillet	S004	Commercial strain	AY540317	New submission
	ATCC 36047	Czechoslovakia	AY368657	Neda, direct submission
P. levis (Berk. & M.A. Curtis) Singer	7947[b]	Denmark	AY450343	Hughes & Petersen, direct submission

Table 1. continued

P. opuntiae (Durieu & Lév.) Sacc.	6241 [b]	Mexico	AY450340	Hughes & Petersen, direct submission
P. ostreatus (Jacq.) Quél.	TENN 53662A	Austria	AY450345	Petersen & Krisai-Greilhuber 1996
	S041	Unkown	AY540324	New submission
	S474	Commercial strain	AY540332	New submission
P. populinus O. Hilber& O. K. Mill. ex O. Hilber	ATCC 52951	USA	AY265840	Choi et al., direct submission
P. pulmonarius (Fr.) Quél.	HMAS 76474	Guangdong, China	AY696298	New submission
	HMAS 76672	Heilongjiang, China	AY696299	New submission
	HMAS 88768/ S449	Jilin, China	AY540330	New submission
	TENN 50539	Sweden	AY450349	Hughes & Petersen, direct submission
'*P. sajor-caju* (Fr.) Singer' (Phoenix Mushroom)	AS 5.353 (=ATCC32078)/ HMAS 89518	India	AY540328	New submission
	AS 5.412/ HMAS 86407	Unkown	AY540329	New submission
	AS 5.593/ HMAS 86396	Unkown	AY696300	New submission
P. smithii Guzmán	CCRC 36229	Unkown	AF265851	Choi et al., direct submission
P.tuber-regium (Rumph. ex Fr.) Singer	RV 95/174.15	Australia	AF109964	Isikhuemhen et al. 2000
Hohenbuehelia grisea (Massee) E. Horak	CCRC 36224	Unkown	AY265835	Choi *et al.*, direct submission
Nematoctonus robustus F. R. Jones	CCRC 32741	Taiwan, China	U51978	Liou & Tzean 1997

[a] The prefix abbreviation for accession numbers are **AS**=the China General Microbiological Culture Collection Center, Beijing; **ASI**=Institute of Agricultural Science and Technology, Suwon, Republic of Korea; **ATCC**=American Type Culture Collection, Rockville, Maryland, USA; **CBS**=Centraalbureau voor Schimmelcultres, Baarn, Holland; **CCRC**=Culture Collection and Research Center, Hsinchu, Taiwan; **Duke**=Duke University, USA; **HMAS**=Mycological Herbarium, Academia Sinica; S=Strain number of this laboratory; **TENN**=Herbarium of University of Tennessee, USA; **RV**= Isolate number of R. Vilgalys' laboratory, Duke University, USA.

[b] The accession numbers without prefix abbreviation are specimens or isolates from the laboratory of R H Petersen, University of Tennessee, USA.

Twenty sequences from related species of *Pleurotus* submitted to the GenBenk by other research groups were retrieved (Table 1). Sequences from *Hohenbuehelia* Schulzer and *Nematoctonus* Drechsler (anamorph of *Hohenbuehelia*) were used as the outgroup, because *Hohenbuehelia* is considered the sister group of *Pleurotus* (e.g. Thorn et al., 2000). All the sequences in this analysis were aligned with Clustal X 1.8 (Thompson et al., 1997) and adjusted manually with BioEdit version 5.0.6 (Hall, 1999) and then analysed by the software PAUP 4.0b10 for Macintosh (Swofford, 2001). The parsimony analysis was performed by heuristic search and tree bisection-reconnection

(TBR) swapping for 1000 replicates. Gaps were set as 'missing' and the characters were specified as unordered and equally weighted. Bootstrap analysis (Hillis & Bull, 1993) was performed by 1000 replications with simple addition sequences to obtain estimates of reliability for nodes.

Results

Description of cultures and specimens of the Phoenix Mushroom

The mycelial mats of the three strains studied are white, with thickset hyphae 1.0–4.5 μm diam. having abundant clamp connextions on potato dextrose agar. The strains fruit on the manmade substrate after 58–73 days from inoculation at room temperature from June to August.

Based on examination of the basidiomata cultivated from the above three strains and of other collections, the morphological characters of the fungus are described bellow.

Pileus 6.0–10.5 cm in diam., flabellate, dimidiate, to orbicular; surface greyish white to greyish brown, smooth, margin lobed, initially inrolled. *Lamellae* decurrent, white, up to 4 mm wide, densely crowded, the base divaricate, with lamellulae. *Stipe* excentric to lateral, 4.5–7.5 × 1.2–2.5 cm, solid, white, clavate. *Context* white, up to 1.5 cm thick at the pileal base, thin at the margin, consisting of interwoven, hyaline, branched hyphae, 4.5–11.0 μm diam., with thin to thickened wall (–1.5 μm) and prominent clamp-connexions. *Spores* 7.0–10.5 × 3.0–4.5 (9.5± 0.4 × 3.9±0.4) μm, Q=2.4, cylindric, hyaline, thin-walled. Spore print white. *Basidia* 26–37 × 5.5–7.5 μm, thin-walled, clavate with four sterigmata. *Cheilocystidia* 18.0–45 × 3.5–6.5 μm, capitate, thin-walled, hyaline. *Pleurocystidia* similar to cheilocystidia, from numerous to very scarce. *Hymenophoral trama* hyaline, irregular, with hyaline hyphae similar to context. *Subhymenial layer* 13.0–18.0 μm, well developed, interwoven. *Pileipellis* a thin cutis of thin-walled generative hyphae, 4.5–7.0 μm diam.

Specimens examined: **Beijing**: Huairou, cultivated from S006, Aug. 2003, X-L Li 006, HMAS 77105; Huairou, cultivated from S492, 12 Aug. 2003, X-L Li 492, HMAS 86390; Huairou, cultivated from S052, 26 Aug. 2003, X-L Li 052, HMAS 86401; Huairou, cultivated from AS 5.593, 28 Sept. 2003, X-L Li 50, HMAS 86396; Huairou, cultivated from AS 5.412, 21 Aug. 2003, X-L Li 49, HMAS 86407; Huairou, cultivated from AS 5.353, 7 Sept. 2003, X-L Li 48, HMAS 89518. **Gansu**: Zhouye (Alt. 2670 m), *Salix* sp. in the mixed forest, 10 July 2002, Q-B Wang 38, HMAS 88762. **Guangdong**: Huidong, on rotten wood, 18 Oct. 1998, H-A Wen, S-X Sun, X-L Mao, HMAS 76474. **Hebei**: Huailai, on the ground, G-H Wu, 8 Nov. 1996, HMAS 76520. **Heilongjiang**: Huma, on wood, Aug. 2000, H-A Wen, HMAS 76672. **Jilin**: Antu (Alt. 705 m), 29 Aug. 2002, X-L Li 166, 29 Aug. 2002, HMAS 88768. **Ningxia**: Liupanshan, on rotten wood, 22 Aug. 1997, H-A Wen & S-X Sun, HMAS 72869. **Shaanxi**: Taibaishan (Alt. 2800 m), on stem of birch, 26 July 1963, Q-M Ma & Y-C Zong 2679, HMAS 33529. **Xinjiang**: Kanasi Nature Reserve (Alt. 1300 m), *Betula platyphylla* Suk. forest, 7 Aug. 2003, M-S Song xj053, HMAS 88755; Kanasi Nature Reserve (Alt. 1300 m), *B. platyphylla* forest, 7 Aug. 2003, M-S Song xj054, HMAS 88764; Buerjin (Alt. 1100 m), on fallen wood of *B. platyphylla*, 5 Aug. 2003, M-S Song xj033, HMAS 88765; Buerjin (Alt. 1100 m), 5 Aug. 2003, W-P Wu & M-S Song xj032, HMAS 88766; Buerjin (Alt. 1100 m), on rotten wood of *B. platyphylla*, 5 Aug. 2003, M-S Song xj036, HMAS 88767. **Yunnan**: Lijiang (Alt. 2600 m), on stem of angiosperm, S-H Wu & R-Y Zeng 9507-46, 31 July 1995, F 4447; Longling (Alt. 2300 m), 6 Sept. 2002, Z-L Yang 3488, HKAS 42148. **Sweden**:

Kinnekulle Nature Reserve, on stem of *Fraxinus* Linn., R.H. Petersen Tennessee, tracking number 4203, 18 Sept. 1991, TENN 50539. **USA**: California, on lupin logs, O. K. Miller 18757, 9 May 1980, VTMH 1400. The above description is based on Chinese specimens examined, especially those cultivated from the Phoenix Mushroom strains. The specimens from Sweden and the USA were examined for comparison.

Based on the fleshy basidioma, monomitic hyphal system of the material examined above, contrasting with tough basidioma, dimitic hyphal system of *Lentinus*, the Phoenix Mushroom is not a member of the genus. Further, *L. sajor-caju* is characterised by the presence of an annulus on the stipe, hyphal pegs in the hymenophoral trama and small basidiospores (5.0–9.0×1.5–2.5 μm; see Pegler, 1983; Pegler & Yao, 1995). Some Chinese collections from Xizang (Medog, on rotten wood, 5 Aug. 1983, X-L Mao 1171, HMAS 52783), Hainan (Xinglong, Mar. 1993, X-L Mao & B Li, HMA S69993; Wuzhi Mont., on fallen wood of broadleaf tree, Mar. 1993, X-L Mao & B Li, HMAS 71640) and Yunnan (Mengla, on rotten wood, 12 Aug. 1999, H-A Wen, X-L Mao & S-X Sun 138, HMAS 76633) match the description of *L. sajor-caju* by Pegler (1983) and Pegler & Yao (1995). The absence of the annulus on the stipe and of the hyphal pegs on the hymenophoral trama, coupled with the larger basidiospores (7.0–10.5 × 3.0–4.5 μm), distinguish the Phoenix Mushroom from *L. sajor-caju*.

The flabellate to orbicular basidiomata, excentric to lateral stipe, monomitic hyphal system and the spore size of the Phoenix Mushroom is very similar to that of *P. ostreatus* and *P. pulmonarius*. Generally, *P. ostreatus* produces darker and larger basidiomata ($\geq$ 12 cm) with imbricate pilei and stipe mostly more lateral than eccentric, and fruits slowly in culture, (16–) 28–53 days at 11°), whilst *P. pulmonarius* has light colour (white, ochraceous to pale buff) and smaller ($\leq$13 cm) basidiomata with single or clustered pilei and stipe mostly more eccentric than lateral, and fruits faster in culture, 13–22 (–27) days at 11° (see Bresinsky et al., 1987). Examination of the epitype of *P. ostreatus* (Austria: Vienna, on *Salix* Linn., 30 Oct. 1994, I. Krisai-Greilhuber Tennessee field No. 6689, TENN 53662A) showed pale greyish brown to dark greyish brown pileus, up to 20 cm diam. Chinese collections (Hebei: Huailai, 8 Nov. 1996, G-H Wu, HMAS 76520; Beijing: Huairou, cultivated from S041, 24 Oct. 2003, X-L Li 41, HMAS 77107; Beijing: Huairou, cultivated from S047, 21 Oct. 2003, X-L Li 47, HMAS 86400; Beijing: Huairou, cultivated from S046, 5 Nov. 2003, X-L Li 46, HMAS 86404; Beijing: Huairou, cultivated from S474, 5 Oct. 2003, X-L Li 474, HMAS 86414) accord with the characters of the epitype of *P. ostreatus*. The smaller (6.0–10.5 cm) and light coloured pileus with faster fruiting rates of the Phoenix Mushroom (58–73 days, compared with 101–124 days for *P. ostreatus* under the same condition) showed a close affinity with *P. pulmonarius*.

Molecular analysis

Sequences of ITS from the three Phoenix Mushroom strains were identical, 579 bp in length. A dataset of 814 bp was established. For the parsimony analysis, 58 sites and 61 sites at both ends were excluded. Of 695 sites included for the analysis, 370 were constant, 76 were variable and parsimony uninformative and 249 were parsimony informative. A heuristic search of the ITS data generated 15 most parsimonious trees with the similar topology. Figure 1 shows one of the trees.

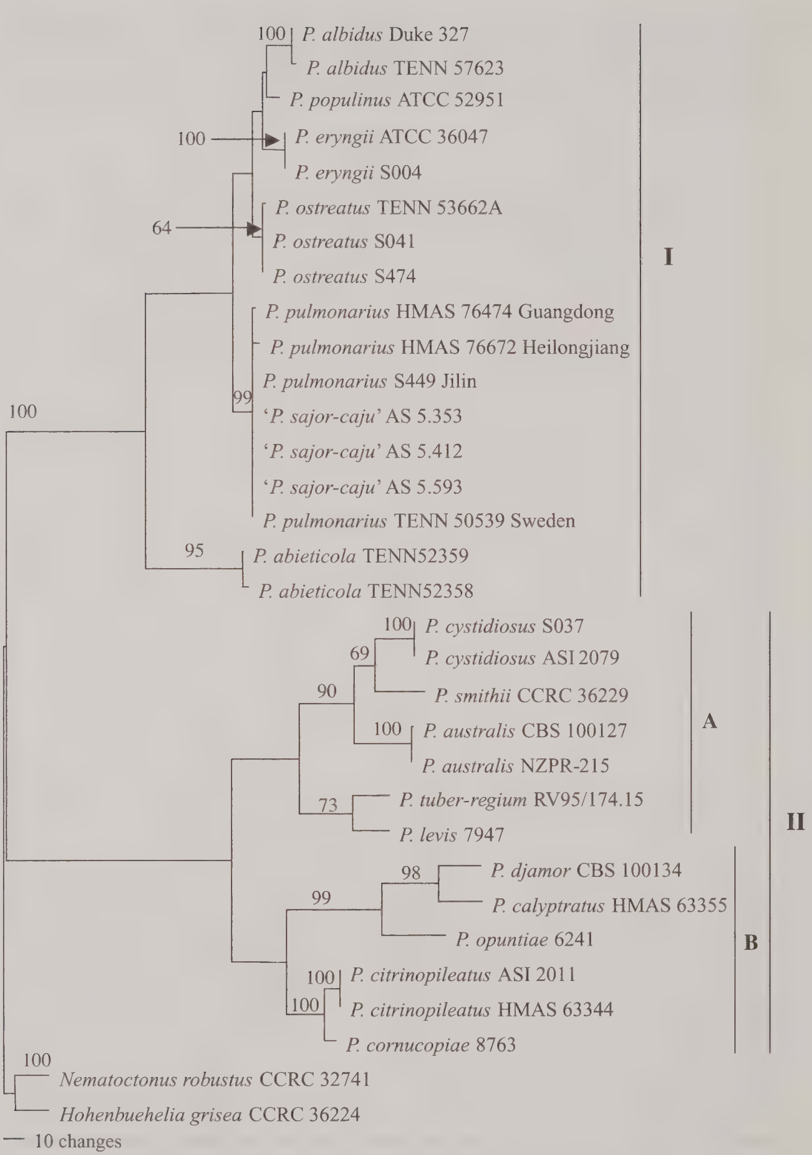
100
P. albidus Duke 327
P. albidus TENN 57623
P. populinus ATCC 52951
100
P. eryngii ATCC 36047
P. eryngii S004
64
P. ostreatus TENN 53662A
P. ostreatus S041
P. ostreatus S474
P. pulmonarius HMAS 76474 Guangdong
P. pulmonarius HMAS 76672 Heilongjiang
P. pulmonarius S449 Jilin
99
'P. sajor-caju' AS 5.353
'P. sajor-caju' AS 5.412
'P. sajor-caju' AS 5.593
P. pulmonarius TENN 50539 Sweden
100
95
P. abieticola TENN52359
P. abieticola TENN52358
I
100
P. cystidiosus S037
69
P. cystidiosus ASI 2079
90
P. smithii CCRC 36229
100
P. australis CBS 100127
P. australis NZPR-215
73
P. tuber-regium RV95/174.15
P. levis 7947
A
98
P. djamor CBS 100134
99
P. calyptratus HMAS 63355
P. opuntiae 6241
B
100
P. citrinopileatus ASI 2011
100
P. citrinopileatus HMAS 63344
P. cornucopiae 8763
II
100
Nematoctonus robustus CCRC 32741
Hohenbuehelia grisea CCRC 36224
10 changes

Fig. 1. One of 15 most parsimonious trees obtained using ITS sequence data based on maximum parsimony inferred by a heuristic tree search. Tree length=676, consistency index=0.7041, retention index=0.8145, rescaled consistency index=0.5735. Numbers above the branches are bootstrap values greater than 50% frequencies.

The analysis of ITS sequences permitted grouping of the *Pleurotus* taxa into two main clades, which are marked as I and II in Fig. 1, although Clade II was not well supported by the bootstrap analysis. Clade I included the monomitic species and Clade II included both the monomitic and dimitic spcies. The relationships among those monomitic species within Clade I were not very clear, lacking bootstrap support on most of the branches. However, six species lineages were distinguishable. The sequences of the three strains of the Phoenix Mushroom examined were clustered with sequences from other three named collections of *P. pulmonarius* from Guangdong, Heilongjiang and Jilin, and the sequence from the Sweden material, TENN 50539. All these sequences are identical except for one substitution from the Guangdong material and three from the Heilongjiang material. Similar changes between sequences were also found in *P. albidus* and *P. abieticola* lineages in Clade I.

There were 10 lineages in Clade II, with more sequence variations than that in Clade I as shown by the branch length (Fig. 1). These lineages were grouped in two subclades, marked as A and B in Fig. 1, although these two subclades were not well supported by bootstrap. The grouping of species in Clade II seemed to be irregularly with regard to morphological characters. However, three species of *Pleurotus* sect. *Coremiopleurotus* Singer (*P. cystidiosus, P. smithii* and *P. australis*) were clustered together in Subclade A, with two others which produce either sclerotia (*P. tuber-regium*) or veil (*P. levis*). The support for grouping within the two subclades is from reasonably to very strong, from 69 % to 100% of bootstraps.

Within Clade I, the species share the character of monomitic hyphae in basidiomata. Most of them also have similar forms of basidiomata, e.g. suborbicular–flabellate and lateral–excentric, except for *P. eryngii*. They are morphologically very similar and there are not many characters available to separate the species in this group. Species in Clade II, however, produce diverse structures, e.g. coremiospores, sclerotia and veil, and have different hyphal systems. More characters can be used to discriminate species in Clade II. It is morphologically more difficult to distinguish the species in Clade I than in Clade II. The molecular data also demonstrate this as there are fewer variations in ITS in Clade I than that in Clade II, as shown in Fig. 1.

Discussion

The confusion of the Latin name of the Phoenix Mushroom was caused from the initial misuse of the name *P. sajor-caju* by Jandaik (1974) to the isolate of a fresh basidioma on a dead stump of *Euphorbia royleana* Boiss. in India. *Pleurotus sajor-caju* was used in the subsequent articles involved with this strain on its nutrition (Jandaik & Kapoor 1975), physiology (Jandaik & Kapoor 1976a, b) and cultivation (Jandaik & Kapoor 1976c). With spread of the fungus in cultivation, the use of the name *P. sajor-caju* (or *L. sajor-caju*) was followed by many (e.g. Bi et al. 1990, 1997; Huang 1993; Zeng 1999; Kim et al. 2001; Han et al. 2003; Chen 2004: as above). The morphological variation of basidiomata in the genus *Pleurotus*, especially in the *P. ostreatus-P. pulmonarius* complex, adds more confusion to the name of the Phoenix Mushroom. Morphological characters have been insufficient to differentiate *P. ostreatus* from *P. pulmonarius* (Bresinsky et al. 1987; Vilgalys et al. 1993; Petersen & Hughes 1993; Zervakis & Balis

1995, 1996; Petersen, 2004: http://fp.bio.utk.edu/mycology/Pleurotus/pleurotusindex.htm), e.g. an European strain named as *P. sajor-caju* was found to produce typical basidiomata of *P. ostreatus* var. *ostreatus* (Guzmán et al. 1994).

Sexual incompatibility (Petersen, 1992; Zervakis & Balis, 1995, 1996) and isozyme analysis (Zervakis & Labarère 1992; Zervakis et al. 1994; Iracabal et al. 1995) were also applied to the studies on the identity of the Phoenix Mushroom. The results suggest that strains ascribed to *P. sajor-caju* had close relationships with those named as *P. pulmonarius*. Based on the analysis of lsu-rDNA and ITS sequences, Vilgalys *et al.* (1996) also found that strains named *P. sajor-caju*, two single-spore isolates from ATCC 32078 (ATCC 32772 as D1824 and ATCC 32771 as D1825) and D257, were clustered within the intersterility group of *P. pulmonarius*. In the study of the sequence and secondary structure of V4, V6 and V9 domains within mitochondrial ssu-rRNA, Gonzalez & Labarère (2000) demonstrated that isolates ascribed to *P. sajor-caju* (numbered as SM 37, SC 960905, SC 960906 and SC 971205) shared the same sequence and structure with those of *P. pulmonarius*. These sexual incompatibility, isozyme analysis and molecular data provided useful information about the identity of the Phoenix mushroom, supporting the conclusion of the present study made from both the morphological and molecular information from the strains.

As indicated by the locality of the specimens examined in this study, the wild *P. pulmonarius* distributes widely in many provinces of China, i.e. Gansu, Guangdong, Hebei, Heilongjiang, Jilin, Ningxia, Shaanxi, Xinjiang and Yunnan. In addition, it was also found in Guangxi (Teng, 1963), Hainan (Huang, 1998), Henan (Teng, 1963), Hong Kong (Chang & Mao, 1995) and Xizang (Mao, 1998). As its distribution range suggests, *P. pulmonarius* seems to be better adapted to and withstand a broader range of climatic variation. While the distribution of *L. sajor-caju* is localised in Southern tropical China, including Fujian, Guangdong, Guangxi, Hainan, Xizang, Yunnan and Xisha islands (Mao, 1998).

The Phoenix Mushroom is now widely cultivated in many countries, especially in Asia, e.g. India (Chang & Mao, 1995), Pakistan (Huang, 1993), Nepal (http://www.instantnepal.com/mushrooms.htm) and Thailand (http://www.fao.org/docrep/003/x6906e/x6906e0c.htm), due to its excellent flavour and texture. Clarification of the real identity of the fungus has international significance. The strain, ATCC 32078, originated from India by Jandaik and delivered to the ATCC by Rangaswami (http://www.atcc.org/) had been also labelled as *Pleurotus* (or *Lentinus*) *sajor-caju* for a long time in the ATCC catalogue (Zervakis & Balis, 1996). The identify of this strain and other strains ascribed to *P.* (*L.*) *sajor-caju* in the ATCC have been relabelled as *P. pulmonarius* (http://www.atcc.org/). However, *P. sajor-caju* is still used to refer to the Phoenix Mushroom in some culture collection centres, e.g. the CGMCC and the Mycotheque de l'Universite catholique de Louvain,Belgium (MUCL) (http://www.belspo.be/bccm/) and in recent articles (e.g. Kim et al., 2001; Han et al., 2003). Combination of both the morphological observation and molecular analysis in this study has firmly confirmed the scientific name and the taxonomic position of the Phoenix Mushroom. It is not a member of *Lentinus*, but of *Pleurotus*. The correct name for the fungus is *P. pulmonarius*. The fungus does not have any close relationships with *L. sajor-caju* (=*P. sajor-caju*) and the misused name of *P. sajor-caju* for this fungus should be avoided.

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Occurrence of *Tuber aestivum* in China

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Abstract—The occurrence of *Tuber aestivum* in China is confirmed based on collections from Sichuan Province. The species is characterized by black or blackish-brown ascomata with prominent polygonal and pyramidal warts, yellowish or olive-brown gleba and irregularly reticulate ascospores. It is here reported from China for the first time with firm evidence of collections. A full description of the species, based on Chinese collections, and comparison with European collections are given, along with a brief discussion on closely related species, *T. mesentericum*, *T. melanosporum* and *T. brumale*. Some other *Tuber* species reported from the same area are also noted.

Key words—Chinese record, distribution, *Tuberaceae*

中文摘要

本文根据在四川采集的标本，确认夏块菌(*Tuber aestivum*)在中国的分布。夏块菌以黑色或黑褐色、具多边锥体形瘤的包被，黄褐色至绿褐色的产孢组织，以及具不规则网纹的孢子为主要特征。本文根据中国的标本对这个种进行了全面描述，并与产自欧洲的标本进行了比较，同时还讨论了该种与其近缘种类的区别。这一报道是该种在中国的第一次具有可靠标本支持的记录。

Introduction

Tuber F. H. Wigg. is an important and cosmopolitan genus of true truffles. Some species of the genus, e.g. *T. magnatum* Pico and *T. melanosporum* Vittad., are greatly sought after for culinary purposes and have high commercial value (Spooner 1993). All species of *Tuber* form ectomycorrhizal associations with tree and shrub hosts, and as such play a key role in forest ecosystems (Spooner 1993, Di Battista et al. 1999). According to the IndexFungorum (http://www.indexfungorum.org/Names/Names.asp 2004), there are currently 234 names published in *Tuber*, whereas about 63 species are recognised worldwide (Kirk et al. 2001).

Since the first report of the genus from China (*T. taiyuanense* B. Liu; Liu 1985), many more species of *Tuber* have been recorded (see Liu & Liu 1994, Chen & Gong 2000, Ren 2003) from the country. Thirty-three taxa have, so far, been reported from 13 provinces in China, mainly from the Northeast and the Southwest regions. Amongst these, 20 taxa are supported by specimens, eight lack citation of specimens or definite

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locality, and the remaining five are based on invalid names (Ren 2003). *Tuber aestivum* Vittad. was reported from forests in the North and the Southwest of China by Mao (1998), but without citation of specimens, and was later excluded by the same author (Mao 2000). This record was also considered doubtful by Xu & Zheng (2003). During the present investigation of *Tuber* species in China, no Chinese specimens under *T. aestivum* could be located in the leading Chinese mycological herbaria, viz. HKAS (Herbarium of Cryptogams, Kunming Institute of Botany, Academia Sinica), HMAS (Mycological Herbarium, Academia Sinica), IFS (Herbarium of the Institute of Applied Ecology, Academia Sinica) and MHSU (Mycological Herbarium, Shanxi University).

Recently, large quantities of fruitbodies of *Tuber* were gathered from Sichuan Province, China, and were identified as *T. aestivum* after comparison with specimens from Austria, Germany, Hungary, Ireland, Italy, Netherlands and the UK. Although there are a few differences between Chinese and European collections, they are considered to be conspecific. The description of the Chinese collections is provided below, with discussion on related species.

Taxonomy

Tuber aestivum Vittad., Monographia Tuberacearum: 38, pl. II, fig. 4 (1831).

Fig. 1

Ascomata hypogeous, 2–10 cm in diam., subglobose, sometimes lobed or irregular in form; blackish-brown or black, glabrous, conspicuously covered with low warts, solid, firm. Warts polygonal and pyramidal, 4–6 (–7)-sided, 2–3 (–5) mm across, 0.5–1.5 mm high, bearing 3–5 vertical ridges and sometimes 3–5 grooves, usually with fine horizontal striae parallel to each polygonal side, apex often depressed. *Odour* slight at first, becoming strong with age, with the smell of boar when fresh and seaweed-like or dry fish-like when dried. *Peridium* variable in thickness, commonly (170–) 200–400 μm thick, pseudoparenchymatous; comprising an outer layer c. 80–140 μm thick, almost opaque in thin section, composed of angular, irregular cells (6.0–) 10.0–15.0 (–21) μm diam., with somewhat thickened, dark red-brown walls 1.0–4.0 μm thick and an inner, hyaline or pale yellow zone of similar cells with thinner walls, merging with glebal tissue of interwoven hyphae. *Gleba* whitish at first, becoming yellowish or olive-brown; marbled with darker glebal tissue and whitish, meandering veins originating from various points on the periphery; plectenchymatous, composed of interwoven hyphae 2.0–4.5 μm diam. *Asci* 60–86 (–100) x 55–72 μm, clavate or subglobose, with a stalk 6.0–14.0 (–20) x 4.0–7.0 (–11.0) μm, arising from a crozier; 1–5 (–7)-spored, randomly disposed in glebal tissue. *Ascospores* ellipsoid, broadly ellipsoid or subglobose, (21–) 24–45 x (17.0–) 21–30 μm excluding ornament, inversely proportional in size to the number of spores in the ascus; spore wall 1.5–2.5 μm thick, at first hyaline to pale yellow, becoming yellowish-brown at maturity, ornamented with a coarse reticulum 2.0–5.5 (–7.0) μm high; meshes variable, (5.5–) 8.0–11.0 μm diam., formed by near hexagonal or irregular meshes numbering 2–4 across width of spore.

Specimens examined: **China**: Sichuan Province, Huidong County, under *Quercus sp*., 21 July 2003, J.-Z. Cao, HMAS 79726; same locality, 9 Sept. 2003, J.-Z. Cao, HMAS 85375; same locality, 24 Sept. 2003, J.-Z. Cao, HMAS 85381, HMAS 85382, HMAS 85383. **Hungary**: date unknown, H. A. Kelly 410, MICH 6761 (University of Michigan Fungus Collection). **Germany**: Nov. 1904, W. Migula 171, MICH 6762. **Austria**: 20 Sept. 1931, H. Lohwag 96, MICH 6763.

Italy: Santi, near L'Aquila, Abruzzi Province, 9 Mar. 1992, R. Fogel F3662, MICH 25498; L'Aquila, under oak 14 Oct. 1987, B.-C. Zhang 37A, HMAS 68437, same locality, same date, B.-C. Zhang 37B, HMAS 68440. **Netherlands**: Baden-Wűsttemberg, Stuftgart-Zuffenhausen, 3 Oct. 1968, Steinmann-Schwid, L 0354671 (National Herbarium Nederland); Moravia centr., Veveří Bítýška, loco calcareo, Querceto-Carpine-tum pr. ruinam Veveří, 300 m alt., 15–28 July 1951, Ing. Karel Kříž, L 0354672; Duitsland, Saarland, bij Bebelsheim, under *Quercus robur*, 28 Oct. 1974, H. A. van der Aa & G. Gross 4338, L 0354673; purchased in Amsterdam, Aug. 1987, D. W. Minter, HMAS 68438. **UK**: Gloucestershire, Aug. 1987, B.-C. Zhang 50, HMAS 68439. **Ireland**: Galway, Loughrea near Athenry, in a lawn near *Quercus*, on calcareous soil, 30 Oct. 2003, communicated by M. Nagle, FC 885, HMAS 85388. The above description is based solely on the Chinese collections. The other specimens from Europe were examined for the purpose of comparison.

Distribution: Europe (Pacioni & Pomponi 1991, Spooner 1993, Mello et al. 2002, Kers 2003), Africa (Pacioni & Pomponi 1991) and Asia (Pacioni & Pomponi 1991, Chevalier et al. 1994, this report).

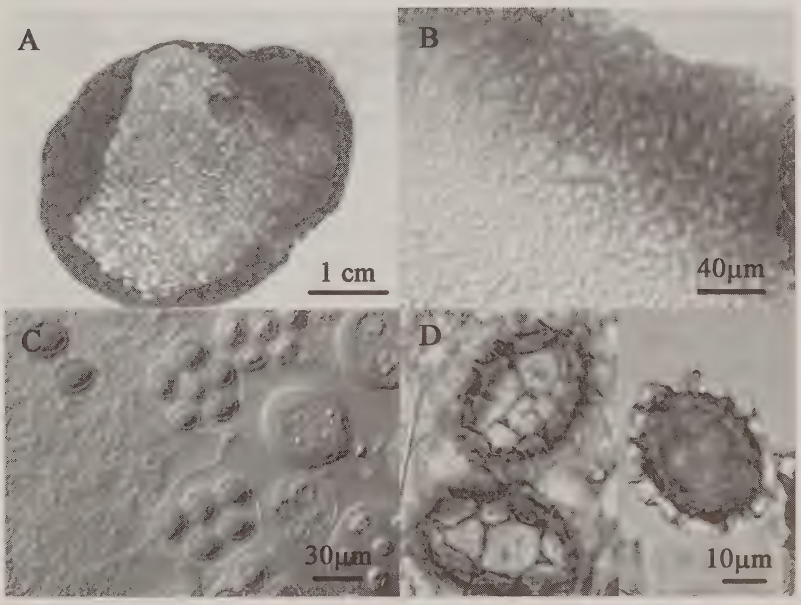

Fig. 1. *Tuber aestivum* (HMAS 85381): A. ascomata; B. section of peridium; C. asci showing stalk and spores; D. spores.

Discussion

Tuber aestivum was originally described from Italy (Vittadini 1831), and has been reported from much of Europe and North Africa though is apparently absent from North America (Pacioni & Pomponi 1991, Spooner 1993). The fungus occurs in association with a variety of deciduous shrubs and trees, particularly with *Fagus* spp and *Quercus robur* on calcareous soil (Spooner 1993, Kers 2003). The species has also been reported in Asia, i.e. Turkey (Pacioni & Pomponi 1991) and U.S.S.R (Chevalier et al. 1994). The discovery of this species in China expands its distribution.

Tuber aestivum is one of the most common species of the genus. It is readily recognised by its black or blackish–brown ascomata with prominent polygonal and pyramidal warts, yellowish or olive-brown gleba and irregularly reticulate spores. The Chinese collections conform to these characters well. Compared with the collections from Europe examined, the Chinese collections show a strong resemblance in the appearance of ascomata, peridial anatomy, gleba, asci, ascospores and ascospore ornamentation, but peridial warts are blunt and also lower than those of European collections. Peridial warts in the European collections, as cited above, were measured as (0.5–) 1.0–2.0 mm high by the present authors, matching that given by Spooner (1993) for British material. Examination of more than 40 ascomata in the present study reveals that both the shape and size of peridial warts are variable, even in a single specimen. Thus, the height of peridial warts is not considered a valuable character for distinguishing this species. The morphology of *T. aestivum* is known to be variable (Pacioni & Pomponi 1991, Wedén et al. 2004a, b) and this may be the reason why there are so many controversial and confusing opinions on the nomenclature and taxonomy of this species (Paolocci et al. 2004). The difference in peridial warts between Chinese and European collections is treated here as within the variation of the species.

Chatin (1887) recognised *T. uncinatum* Chatin as distinct from *T. aestivum*, but the distinction between the two has been ambiguous since that time. Succeeding authors have treated *T. uncinatum* as either a subspecies (Pacioni & Pomponi 1991), a variety (Chevalier et al. 1994), a distinct species (Mello et al. 2002), or simply a synonym of *T. aestivum* (Wedén et al. 2004a, b). The height of the spore reticulum, whether greater or less than 4 μm, was considered as the most useful morphological character for distinguishing the two taxa (Riousset et al. 2001, Mello et al. 2002). However, ascospores of the specimens observed by the present authors have an ornamentation varying from 2.0–5.5 (–8.0) μm high and this range of variation is occasionally present in a single ascospore. An intermediate height of spore reticulum has also been reported by Mello et al. (2002), Kers (2003) and Paolocci et al. (2004). Therefore, the height of spore ornamentation cannot be used to separate *T. aestivum* and *T. uncinatum*. Based on ITS/RFLP analyses and a phylogenetic study of ITS, ß-tubulin and EF 1-α genes, Paolocci et al. (2004) demonstrate that *T. uncinatum* and *T. aestivum* belong to the same species.

Tuber aestivum is closely related to *T. mesentericum* Vittad. 1831 (Spooner 1993), having black warted ascomata and reticulate spores. It is distinguished from *T. mesentericum* particularly by lacking a distinct basal cavity in the ascomata. Ascomata of *T. brumale* Vittad. and *T. melanosporum* (the Périgord Truffle), both having a blackish and warted surface, are similar in appearance to those of *T. aestivum*. However, they are readily distinguished from *T. aestivum* by the spiny rather than reticulate spore ornamentation as well as the dark colour of the gleba.

Four further species of *Tuber* have also been collected from Huidong County, Sichuan Province, China, namely *T. sinense* K. Tao & B. Liu (Tao et al. 1989), *T. gigantosporum* Y. Wang & Z. P. Li (Wang & Li 1991), *T. pseudoexcavatum* Y. Wang et al. (Wang et al. 1998) and *T. huidongense* Y. Wang (Wang & He 2002). They differ from *T. aestivum* most notably in their yellowish brown or reddish brown ascomata, dark colour of gleba at maturity and spiny-reticulate ascospores. In addition, ascomata of *T. gigantosporum* and *T. huidongense* are hairy, lacking peridial warts. Although *T. pseudoexcavatum* has verrucose ascomata, it is easily distinguishable from *T. aestivum* by the polygonal warts on ascomata of the latter. The polygonal warts in *T. sinense* lack the fine horizontal striae as seen in *T. aestivum*. Furthermore, as indicated by its common name, Summer Truffle, *T. aestivum* occurs in summer or early autumn, whilst most of the larger sized dark truffles produce their fruitbodies in late autumn or winter in the same area of Sichuan Province.

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Some notes on the genera *Bovista* and *Lycoperdon* (*Lycoperdaceae*) in Brazil

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Abstract - Four species of *Bovista* and *Lycoperdon* occurring in Brazil are described: *B. aestivalis, L. nigrescens* (new record for South America), *L. perlatum* and *L. pyriforme* (new record for northeast Brazil). A key for these species and SEM images of spore ornamentation are provided.

Key words - Gasteromycetes, *Agaricales,* neotropics, taxonomy

Introduction

The genus *Bovista* was erected by Persoon in 1794 and is mainly characterized by the basidiomata detached from the substrate at maturity and a capillitium formed by discrete units. Later, in 1801, Persoon established *Lycoperdon* that became the type genus of *Lycoperdaceae* (Chevallier 1826). *Lycoperdon* is recognized by its basidiomata with apical pore, hyphae without clamps, capillitium branched without tapered tips. Currently, *Bovista* and *Lycoperdon* comprises about 46 and 50 species, respectively, usually having a broad geographical distribution (Kirk et al. 2001).

Previous to the present study 16 species of *Lycoperdon* and two of *Bovista* were recorded from Brazil, by Rick (1961), Homrich (1969) and Bononi et al. (1981): *Bovista africana* Kreisel, *B. bicolor* Léveillé, *L. acuminatum* Fr., *L. brasiliense* Speg., *L. candidum* Pers., *L. cupricum* Bonord., *L. dominicensis* Massee, *L. fuscum* Bonord., *L. gemmatum* Batsch, *L. juruense* Henn., *L. perlatum* Pers., *L. pussillum* Batsch, *L. pyriforme* Schaeff., *L. rarum* Rick, *L. simulatum* Peck, *L. subincarnatum* Peck, *L. tropicale* Speg., *L. wrightii* Berk. & M.A. Curtis. Pursuing our previous goal, to obtain a better understanding on the diversity of the Brazilian gasteroid fungi (Baseia & Milanez 2001a, 2001b, 2001c, 2002a, 2002b, 2002c, 2002d, Baseia & Galvão 2002, Baseia 2003, Baseia et al. 2003a, 2003b), we highlight here a few species of the *Lycoperdon* and one of *Bovista*.

Materials and methods

Mycological surveys were based at the ecological stations of Jataí (21°33'-21°37'S and 48°45'-48°51'W) and Itirapina (22°28'-22°30'S and 48°17'-48°19'W) and the biological reserve of Moji-Guaçu (22°15'-22°16'S and 47°08'-47°-12'W), all located in the state of São Paulo; plus the biological reserves of Serra Negra (8°38'-8°35'S and

38°02’-38°04’W) and Gurjaú (8°21’30”-8°12’S and 31°56’30”-35°45’W), both lying in the state of Pernambuco.

Basidiomata were examined in the field for their fresh characteristics. Colours were coded according to Kornerup & Wanscher (1978) and described subjectively. Basidiomata were dried slowly over a stove and placed in containers with naphthalene to prevent the attack by insects in the excessively humid conditions. Microscopic anatomical details were determined from dried specimens with a Zeiss microscope with bright field and phase contrast optics. Features were observed in 3% KOH and Melzer´s reagent. Spores were examined in a Philips XL 20 Scanning Electron Microscope (SEM). Herbarium names are abbreviated according to Index Herbariorum (Holmgren et al. 1990). The material studied is preserved in SP and URM.

Taxonomy

Key to the species of *Bovista* and *Lycoperdon* in the present study

1	Exoperidium surface smooth or granulate	2
1’	Exoperidium surface warted	3
2	Basidioma globose; capillitium threads 2-3 μm diam, pitted, spores verrucose	*B. aestivalis*
2’	Basidioma pyriforme; capillitium threads3-3·5 μm diam not pitted, spores verruculose	*L. pyriforme*
3	Exoperidium covered by dark setae (6F4, dark brown), spores3.5-4 μm diam, verrucose	*L. nigrescens*
3’	Exoperidium covered by light setae (3B2, pale yellow), spores 4-5 μm diam, equinulate	*L. perlatum*

Descriptions of the species

Bovista aestivalis (Bonord.) Demoulin, Beih. Sydowia 8: 143, 1979. Fig. 1

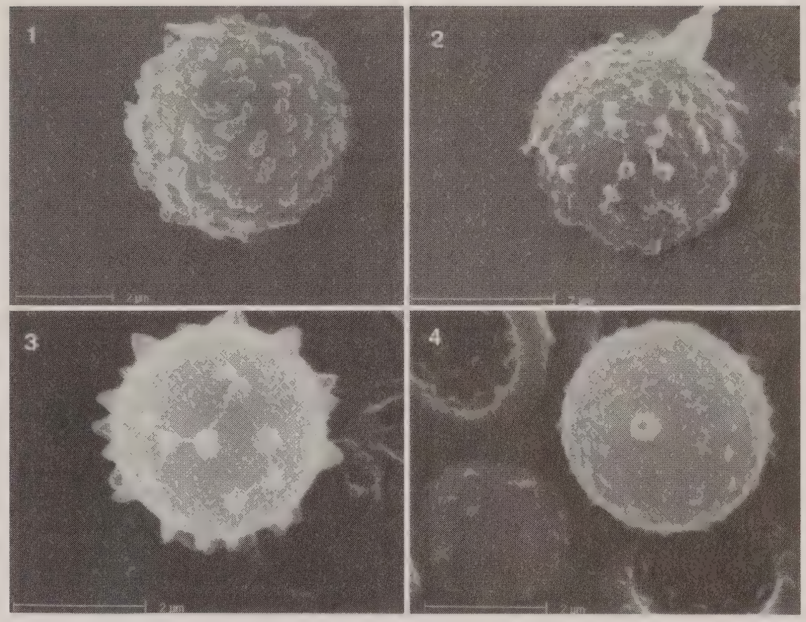
Basidiomata 1–1·5 cm diam, globose; exoperidium smooth, yellowish-brown (5E5 to 5F6), 200–235 μm thick; endoperidium light brown (7D5), apical pore lacerate; glebal mass yellowish-brown (5F6) to grey (5F1), subgleba absent, capillitium threads 2–3 μm diam, branched, sparsely pitted, pale brown; spores 35–4 μm diam, verrucose, pale brown.

Habitat: in groups on sandy soil.

Distribution: United States of America (Coker & Couch 1928), Mexico (Pérez-Silva & Calderón-Villagomes 1989), Europe (Calonge 1998).

Remarks: This species can be easily segregated by the small yellowish globose basidiomata; subgleba absent and spore ornamentation which, when observed under SEM, comprises rounded, unevenly distributed, sometimes confluent, warts. This represents the first record of *Bovista aestivalis* from South America.

Material studied: Brazil, São Paulo state, Itirapina ecological station, 20/I/2001 (SP 307570); Jataí ecological station, 09/IV/2000 (SP 307571). Pernambuco state, Serra Negra biological reserve, 12/IV/2003 (URM 77080).



Figures 1-4. SEM-photographs of the spores: 1. *Bovista aestivalis*; 2. *Lycoperdon nigrescens*; 3. *L. perlatum*; 4. *L. pyriforme*

Additional material studied: Canada, Ontario, XII/1969, det. D. M. Dring (SP 50639).

Lycoperdon nigrescens Pers.: Pers., Syn. Meth. Fung. 146, 1801. Fig. 2

Basidiomata 2–2·5 cm broad, 3–4 cm high, turbinate to subglobose; exoperidium spinose forming cylindrical to slightly conical warts, 1–2 mm long, dark brown (6F4), very thin; endoperidium brown (6E4), papery, apical pore fimbriate; gleba yellowish-brown (5F6) to brownish-grey (6E4); subgleba yellowish-brown (5F6), reduced; capillitium threads 3–4 μm diam, branched, pitted, brown; spores 3.5–4 μm diam, verrucose, brown.

Habitat: solitary on litter.

Distribution: Holland (Lange 1948), Mexico (Pérez-Silva & Calderón-Villagómes 1989), Belgium (Moyersoen & Demoulin 1996), British Isles (Pegler et al. 1995), Spain (Calonge 1998).

Remarks: *Lycoperdon nigrescens* is very similar to *L. perlatum*, but can be easily recognized mainly by the dark basidiomata covered by dark conical spines. Under SEM, the spore ornamentation comprises rounded warts unevenly distributed, sometimes confluent with distinct apiculus. Geographical distribution was previously limited to Europe and North America. This collection represents the first occurrence of *L. nigrescens* for South America.

Material studied: Brazil, São Paulo state, Moji-Guaçu biological reserve, 07/II/2000 (SP 307563).

Lycoperdon perlatum Pers.: Pers., Syn. Meth. Fung. 145, 1801. Fig. 3

Basidiomata 3–5 cm diam, turbinate; exoperidium spinose with conical spines, 1·5–2 mm long, pale yellow (3B2); endoperidium light brown (5D5), apical pore lacerate; glebal mass yellowish-brown (5F3), subgleba light brown (5D3), developed, spongy, capillitium threads 3–4 μm diam, unbranched, smooth, pitted, pale brown to hyaline; spores 4–5 μm diam, equinulate, pale brown.

Habitat: groups on litter.

Distribution: South Africa (Bottomley 1948), Norway (Eckblad 1955), Panama (Garner 1956), Canada (Bowerman 1961), Ghana (Dring 1964), Belgium (Demoulin 1968, Moyersoen & Demoulin 1996), France (Demoulin 1983), China (Liu 1984), Spain (Calonge 1998), Turkey (Watling & Gregory 1977), Mexico (Guzmán-Dávalos & Guzmán 1979), Brazil (Bononi et al. 1981), Mongolia (Dörfelt & Bumžaa 1986), England (Pegler et al. 1995).

Remarks: This species has world-wide distribution and is characterized by its great morphological and ecological variation (Herrera & Guzmán 1961), for this reason it is sometimes subdivided in varieties. *Lycoperdon perlatum* is segregated by its basidiomata with a pseudostipe and spinose exoperidium. The spore ornamentation, when observed under SEM, comprises usually isolated spines although connections between the spines may occur. This is the first record of *L. perlatum* from Northeastern Brazil.

Material studied: Brazil, São Paulo state, Itirapina ecological station, 21/I/2000 (SP 307564); Jataí ecological station, 09/III/2000 (SP 307563). Pernambuco state, Gurjaú ecological station, 03/V/2003 (URM 77081).

Additional material studied: USA, Idaho, 27/IX/1946, det. W. B. Cooke (SP 60014), England, X/1966, det. D. N. Pegler (SP 107408), Brazil, Porto Alegre, XII/1969, det. D. M. Dring (SP 61712).

Lycoperdon pyriforme Schaeff.: Pers., Syn. Meth. Fung. 148, 1801. Fig. 4

Basidiomata 2–3 cm diam, pyriform; exoperidium granulate, yellowish-brown (4F2 to 5F5), 270–320 μm thick; endoperidium light brown (5D5), apical pore lacerate; glebal mass light brown (3D3 to 3D7), subgleba yellowish-brown (5E5), developed, cottony, capillitium threads 3–3·5 μm diam, smooth, branched, not pitted, pale brown to hyaline; spores 35–4 μm diam, slight verrucose, pale brown.

Habitat: groups on dead wood.

Distribution: Australia (Lloyd 1905b), England (Lloyd 1905a), USA (Coker & Couch 1928), Netherlands (Perdeck 1950), Norway (Eckblad 1955), Canada (Bowerman 1961), Congo (Dissing & Lange 1962), Mexico (Guzmán 1963), Belgian (Demoulin 1968), Brazil (Rick 1961), Spain (Calonge & Demoulin 1975; Calonge 1998), China (Liu 1984), Mongolia (Dörfelt & Bumžaa 1986).

Remarks: This species is mainly recognized by its pyriform basidiomata and lignicolous habitat. The spore ornamentation, when observed under SEM, comprises isolated and inconspicuous warts. This is the first report of *L. pyriforme* from Northeastern Brazil.

Material studied: Brazil, São Paulo state, Itirapina ecological station, 30/I/1999 (SP 307567), Jataí ecological station, 02/II/1999 (SP 307568), Mogi-Guaçu biological reserve, 27/III/2001 (SP 307569).

Additional material studied: England, 01/X/1967, det. N. H. Sinnott (SP 107409).

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A new species of *Gloeocantharellus* (Fungi-Basidiomycetes) from Colombian Amazonia

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Abstract - A new taxon of *Gloeocantharellus* is proposed as *G. uitotanus*. The species was collected in a terra firme forest in the northern part of the Middle Caquetá in the Amazonian region of Colombia. This species is characterized by having a combination of characters not found in other species of the genus: dry pileus surface which is smooth, areolate and bright peach red to reddish brown; and size, shape and ornamentation of basidiospores that are ellipsoidal to amygdaliform with rugulose walls. The genus *Gloeocantharellus* has five species with mainly neotropical and pantropical distribution. *Gloeocantharellus uitotanus* constitutes the sixth species of the genus, and it is known only from Colombia.

Key words - Amazonas, Basidiomycetes, *Gomphaceae*

Resumen - Una nueva especie de *Gloeocantharellus* es propuesta como *G. uitotanus*. El espécimen que representa este taxón se encontró sobre suelo, en bosque de terra firme, en la zona norte de la región del Medio Caquetá, Amazonía Colombiana. Esta especie se caracteriza por tener una combinación de caracteres diferentes a las encontradas en otras especies del género, como son la superficie del píleo seca, glabra, areolada, de color rojo brillante a rojo-marrón y tamaño, forma y ornamentación de las basidiosporas que son elipsoides a amigdaliformes y con paredes rugulosas. El género *Gloeocantharellus* tiene cinco especies de distribución tropical y pantropical principalmente. *G. uitotanus* se constituye en la sexta especie del género y hasta el momento solo se ha encontrado en Colombia.

Introduction

Colombia is expected to have a highly diverse mycota due to the great variation in climatic zones, but our knowledge of this diversity is still very limited and only a small fraction of the expected taxa have been reported. Most of these reports have been based on collections from mountainous regions as most of the mycological studies have been limited to these areas (Franco-M. & Uribe-C. 2000; Henao-M. 1989, 1990, 1997; Tobón 1991; Uribe-M. 1995). Data on the diversity, biology and ecology of the mycota from Colombian lowland forests are lacking. Although the Amazonian region and the Pacific Chocó area are characterized by high biodiversity of flora and fauna (Etter 1997; Rangel-Ch. et al. 1995a, 1995b; Duivenvoorden & Lips 1993), very few mycological investigations have occurred in these areas. New fungal taxa have been identified in a study of the uses and handling of fungi by the Uitoto ethnic group, carried out in the region of Middle Caquetá, along the banks of the Caquetá river, situated between the departments of Caquetá and Amazonas. In this paper *Gloeocantharellus uitotanus* is described as a terrestrial macrofungus collected in a terra firme tropical rain forest. The indigenous people are not reported to use this fungus, but they recognize this species as "the land mushroom or fungus of earth" (hongo de tierra) (Vasco-P. 2002) in reference to the habitat of this fungus.

Methods

Color designations given within parentheses are from Kornerup & Wanscher (1983). Line drawings were made with the aid of a drawing tube. All micromorphological structures were measured in 3% KOH. Letter abbreviations describing basidiospore size are: n = number of spores measured, x = mean length x mean width, Q = mean length/width ratio.

Taxonomy

Gloeocantharellus Singer is a poorly known genus that belongs to the *Gomphaceae* Donk. The genus was proposed by Singer in 1945 to include species characterized by the presence of warty spores and cyanophilous gloeocystidia (Singer 1945; Singer 1986; Kirk et al. 2001). Singer considered *Gloeocantharellus* as an intermediate genus between *Gomphus* and *Cantharellus* because it has characteristics shared by these two genera (Singer 1945; Corner 1966). The cantharelloid basidiomes and the bifurcate lamellae are similar to *Cantharellus*, but the hymenophore is not interveined. The basidiospores of *Gloeocantharellus* are verrucose or warty and the cystidia, also called gloeocystidia, are immersed in the hymenophoral trama (as in *Gomphus*), have oily contents, and are cyanophilous (Singer 1945; Corner 1966). Corner (1966, 1969) proposed that *Gloeocantharellus* is more closely related to *Paxillus* than to *Cantharellus*, since they share an agaricoid form, the presence of caulocystidia and subhymenial cystidia. However, the presence of cheilocystidia and the ornamented spores separates these genera considerably (Corner 1966, 1969; Petersen 1971, Watling & Meijer 1997). Phylogenetic studies of the family *Gomphaceae* show that *Gloeocantharellus* is very close and basal to *Gomphus* (Pine et al. 1999; Villegas et al. 1999).

Five species of *Gloeocantharellus* have been described to date. *Gloeocantharellus purpurascens* (A. H. Smith & Hesler) Singer was described from North America and has also been reported from French Guyana (Corner 1966; Petersen 1971). *Gloeocantharellus corneri* (Singer) Corner was described from Sri Lanka and has also been reported from Brazil and French Guyana (Corner 1969; Petersen 1971; Pegler 1986; Watling & Meijer 1997). Three other species of *Gloeocantharellus* are only known from SE Asia and Melanesia: *G. echinosporus* Corner from Malaysia,

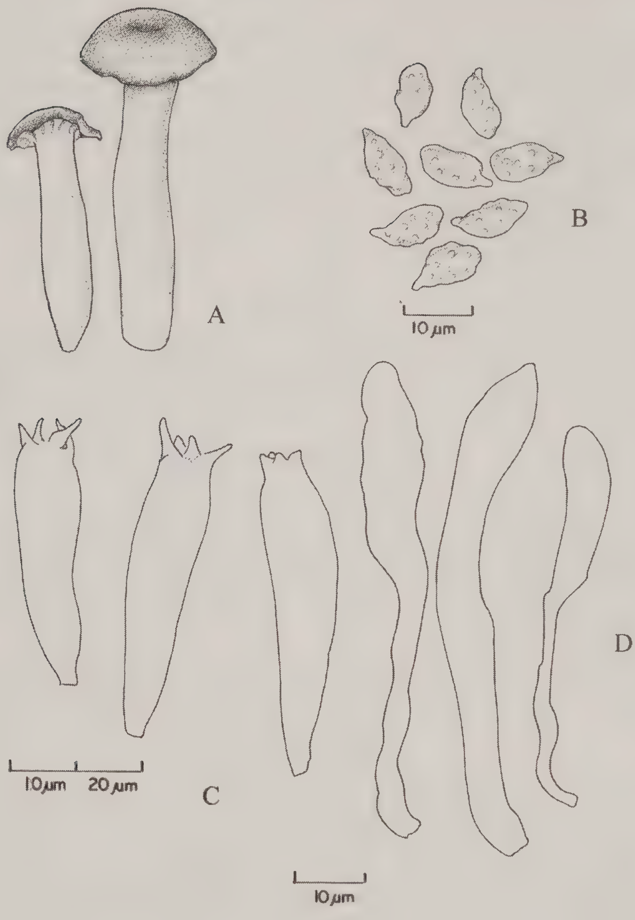

Fig. 1. *Gloeocantharellus uitotanus* A Habit; B Basidospores; C Basidia; D Gloeocystidia

Indonesia, Solomon Islands and Melanesia (Corner 1969; Pegler 1986), *G. lateritius* (Petch) Corner from Ceylon (Petersen 1971), and *G. okapaensis* (Corner) Corner from New Guinea and Solomon Islands (Corner 1969). *Gloeocantharellus uitotanus* from Colombia is the sixth species. A species of *Gomphus* described from Guadaloupe that has recently been found in Belize, *Gomphus viride* (Pat.) Singer, may also belong in the genus *Gloeocantharellus* (D. J. Lodge, pers. com., 19 July 2003).

Gloeocantharellus uitotanus Vasco-Palacios & Franco-Molano *sp. nov.*

(Fig. 1. A-D)

Gloeocantharellus uitotanus ae *G. okapaensis* maxime simile est; ex quod autem in egestatibus pileocystidiarum et in mensura basidiarum disimile est. Basidiarum in *Gloeocantharellus uitotanus* 33-50 x 7-10 μm mensurae sunt, aliter in *G. okapaensis* 55-70 x 8.5-10 μm basidiarum sunt mensurae.

Etymology: Named after the Uitoto indigenous ethnic group that lives in the region of the Middle Caquetá in the Amazonas Department of Colombia.

COLOMBIA. DPTO AMAZONAS: Los Monos, at the south side of the Caquetá river, 220-240 m. altitude, 24 September 2001, gregarious, growing on ground in argillaceous soil, A. Vasco-P. 376 (**HOLOTYPE, HUA**).

Description

Pileus 2-3.6 (-6) cm diam., plano-convex, slightly depressed at the center; surface humid and bright when young, dry and bright in mature specimens, smooth, areolate, bright peach red to reddish brown (near 8C8-9C8), paler towards the margin; *margin* entire, inrolled when young. **Context** up to 1 cm thick, white, unchanging when bruised or exposed, continuous with the stipe. Odor and taste not distinctive. **Lamellae** up to 2 mm broad, subdistant, subdecurrent, some anastomosing towards the stipe, pale yellow (4A2); margin entire or fimbriate. **Stipe** 5-7 cm long., 1.2-1.5 cm diam. near the apex, and 0.8 cm diam. at the base, tapered downward; *surface* dry, with scanty hairs at the apex; hairs reddish brown on pale yellow (3A2) background; *interior* white, unchanging, fleshy, and solid. No reaction was observed with KOH. **Spore print** not obtained.

Basidospores (Fig. 1B) (8-) 8.8-12 x (4-) 4.8-6 (-6.4) μm (x = 9.5 x 5 μm, n = 40, Q = 1.89), ellipsoid to amygdaliform, hyaline in KOH, cyanophilous in Cotton blue, inamyloid in Melzer's reagent; *spore wall* somewhat thick, rugulose. **Basidia** (Fig. 1C) 33-50 x 7-10 μm, clavate, with 4-sterigmata, thin-walled, hyaline, inamyloid, with clamp connections at the base; sterigmata up to 7 μm long. **Pileipellis** an ixocutis of a compact layer of repent and interwoven hyphae; hyphae up to 4 μm diam., with thin, smooth, inamyloid walls, reddish in H_2O, and reddish but soon hyaline in KOH. **Trama of pileus** monomitic, composed of interwowen, generative, thin-walled, hyaline, inamyloid hyphae, 3.2-4 μm diam. **Hymenophoral trama** irregular, composed of thin-walled, inamyloid hyphae, up to 4 μm diam; oleiferous hyphae clavate, flexuose to cylindrical, up to 5 μm diam, with granular and yellow contents in KOH, cyanophilous. **Gloeocystidia** (Fig. 1D) 64-104 x 6.0-8.8μm, inmersed 55 μm in the trama and projecting about 20 μm beyond the basidia, elongated, fusiform to sublanceolate at apex, with yellow content in H_2O and KOH, cyanophilous, thin-walled. **Stipitipellis** formed of a compact layer of vertically arranged interwoven hyphae giving rise to bundles of caulocystidia. **Caulocystidia** 30-42(-50) x 5- 9 μm narrowly clavate, clavate to cilindric, with yellow content in H_2O and KOH. Clamp connections abundantly present.

Gloeocantharellus uitotanus is very similar to *G. okapaensis* from which it differs in the morphology of pileipellis, chemical reaction of the pileipellis and stipitipellis and size of the basidia. While in *Gloeocantharellus uitotanus* the pileipellis is an ixocutis, the hyphae of the pileipellis and stipitipellis do not react with KOH and basidia are 33-50 x 7-10 µm. In *G. okapaensis* the pileipellis is a dermis formed by hyphae more or less divergent over the center of the pileus, the pileipellis and stipitipellis turn reddish in KOH and the basidia are larger (55-70 x 8.5-10 µm). *Gloeocantharellus okapaensis* has been reported from New Guinea and Solomon Islands (Corner 1969). *Gloeocantharellus corneri*, reported from French Guiana and Brazil, differs from *G. uitotanus* by the dull colour of the pileus, and because the pileipellis, stipitipellis and gloeocystidia turn reddish brown in KOH. *Gloeocantharellus corneri* also has bigger spores and basidia. *Gloeocantharellus purpurascens* reported from French Guiana, differs from *G. uitotanus* in having pileocystidia of two types, and bigger basidia (55-70 x 8.4-10.5 µm). *Gloeocantharellus echinosporus* reported from Malayasia, Indonesia, Solomon Islands and Melanesia differs from *G. uitotanus* by having echinulate basidiospores and because the gloeocystidia, the pileipellis and the stipitipellis turn reddish in KOH. *Gloeocantharellus lateritius*, known only from Ceylon, differs from *G. uitotanus* in having a finely felty pileus surface, and the gloeocystidia, pileipellis and stipitipellis turn reddish in KOH as in *G. corneri*, *G. okapaensis* and *G. echinosporus*.

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Parmeliaceae (Ascomycota) lichens in China's mainland III. The genus *Parmotrema*

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Abstract—The genus *Parmotrema* in mainland China has been revised and 37 species are recognized. Of these *Parmotrema laeve* is reported as a new combination, 12 species are reported as new to China [*P. applanatum*, *P. andinum*, *P. deflectens*, *P. eunetum*, *P. gardneri*, *P. immiscens*, *P. louisianae*, *P. margaritatum*, *P. pseudotinctorum*, *P. sipmanii*, *P. subarnoldii* and *P. subochraceum*] and 3 species are recorded in mainland China for the first time [*P. dilatatum*, *P. permutatum*, and *P. subcorallinum*]. *Parmotrema subtropicum* is reduced to synonymy with *P. overeemii,* while the occurrence of 6 species reported previously could not been confirmed [*P. latissimum*, *P. conformatum*, *P. hababianum*, *P. perforatum*, *P. sulphuratum* and *P. zollingeri*].

Key words—Asia, lichen, taxonomy

Introduction

The genus *Parmotrema* was first proposed by Massalongo (1860), but this name was not generally accepted and *Parmotrema* lichens were included in *Parmelia* sensu lato until 1974. Vainio (1890) introduced *Parmelia* subgenus *Euparmelia* section *Amphigymnia* Vain. to accommodate these lichens and this classification was followed by Zahlbruckner (1926). Dodge (1959) subsequently raised this section to subgeneric level and Hale (1965) monographed *Parmelia* subgenus *Amphigymnia*. More recently, Hale (1974) resurrected *Parmotrema* to include all taxa previously included in the subgenus *Amphigymnia* as well as the *Parmelia reticulata* group, previously included in *Parmelia* subgenus *Euparmelia* section *Irregulares* (Vain.)Vain. [but currently included in the genus *Rimelia* Hale & Fletcher (Hale & Fletcher 1990)]. A further genus, *Rimeliella* Kurok., was segregated from *Parmotrema* by Kurokawa (1991). However, this genus has since been reduced to synonymy with *Canomaculina* Elix

& Hale (Elix 1997), a genus originally segregated from *Parmelina* Hale (Elix & Hale 1987). *Canomaculina* in mainland China has been revised by J.B. Chen *et al.* (2003) and *Rimelia* will be reviewed in the future. The present paper considers the genus *Parmotrema.*

Parmotrema is characterized by large thalli with broad lobes (usually more than 5 mm wide), a palisade-plectenchymatous upper cortex with a pored epicortex (lacking pseudocyphellae) and a lower surface with a broad, naked marginal zone and sparse, simple rhizines in the thallus center. This genus is the second largest in the *Parmeliaceae* and comprises more than 300 species (Elix 1994; B.Hale & DePriest 1999), which are widely distributed in tropical and temperate regions of the world (Elix 1994; Krog 1982). Wei (1991) recorded 32 species of *Parmotrema* in China, but *P. cetratum* (Ach.) Hale and *P. reticulatum* (Taylor) M. Choisy are currently considered to belong to the genus *Rimelia* while *P. subtinctorum* (Zahlbr.) Hale and *P. ultralucens* (Krog) Hale are considered to belong to *Canomaculina.* At that time *P. subcorallinum* Hale (Hale) was known from Taiwan but not from mainland China. Thus 27 species of *Parmotrema* sens. str. have been recorded in mainland China, but the Chinese species of the genus have not been revised prior to the present study. Furthermore, many of the previous authors failed to examine the secondary chemistry, a key character for the segregation and identification of parmelioid lichens.

The present study has identified 37 species of *Parmotrema* in mainland China. *Parmotrema laeve* (Zhao) J.B. Chen & Elix (≡ *Parmelia yunnana* var. *laevis* Zhao) is reported as a new combination, 12 species are reported as new to China [*P. applanatum*, *P. andinum*, *P. deflectens*, *P. eunetum*, *P. gardneri*, *P. immiscens*, *P. louisianae, P. margaritatum*, *P. pseudotinctorum*, *P. sipmanii, P. subarnoldii* and *P. subochraceum*] and 3 species are recorded in mainland China for the first time [*P. dilatatum*, *P. permutatum*, and *P. subcorallinum*]. *Parmotrema subtropicum* is reduced to synonymy with *P. overeemii,* while the occurrence of 6 species reported previously could not been confirmed [*P. latissimum*, *P. conformatum*, *P. hababianum, P. perforatum*, *P. sulphuratum* and *P. zollingeri*] and are not included in the present paper

Materials and Methods

We have studied the morphology, anatomy and chemistry of approximately 800 specimens of *Parmotrema* housed in HMAS-L. Morphology was examined using a Zeiss Stemi SV6 or a Zeiss Stemi 2000C stereo microscope, and a Zeiss Axioscop 40 or a Zeiss Axiolab compound microscope. Chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson *et al.* 1981; Culberson & Johnson 1982; Elix & Ernst-Russell 1993), high performance liquid chromatography (Elix *et al.* 2003) and comparison with authentic samples. Unless stated otherwise all cited specimens are housed in HMAS-L.

Keys to species of *Parmotrema* in mainland China

KEY 1: Thallus with soredia

1. Lobes distinctly ciliate 2
1. Lobes eciliate or very sparsely ciliate 13

2. Medulla yellow, gyrophporic acid and eumitrins present . . . . *P. permutatum*
2. Medulla white 3

3. Medulla K+ yellow or red, salazinic or stictic acid present 4
3. Medulla K–, salazinic and stictic acids absent 5

4. Medulla K+ yellow then red, salazinic acid present . . . . *P. margaritatum*
4. Medulla K+ persistent yellow, stictic acid present . . . . *P. chinense*

5. Medulla P+ red, protocetraric acid present 6
5. Medulla P–, protocetraric acid absent 7

6. Alectoronic acid present . . . . *P. deflectens*
6. Echinocarpic and ±usnic acids present . . . . *P. dilatatum*
6. Alectoronic and echinocarpic acids absent . . . . *P. subarnoldii*

7. Medulla C+ red, gyrophoric acid present . . . . *P. sancti-angelii*
7. Medulla C–, gyrophoric acid absent 8

8. Upper surface strongly maculate . . . . *P. pseudonilgherrense*
8. Upper surface emaculate or very weakly maculate 9

9. Medulla KC+ red, alectoronic acid present 10
9. Medulla KC–, alectoronic acid absent . . . . *P. grayanum*

10. Lower surface with an ivory to tan marginal zone . . . . *P. louisianae*
10. Lower surface with a brown to dark brown margin zone 11

11. Ascospores short (13–15 μm); bourgeanic acid present . . . . *P. sublatifolium*
11. Ascospores longer (15–22 μm), bourgeanic acid absent 12

12. Conidia filiform, 10–14 μm long . . . . *P. arnoldii*
12. Conidia rod-shaped, 5–6 μm long . . . . *P. rampoddense*

13. Medulla K+ red, salazinic acid present . . . . *P. cristiferum*
13. Medulla K– or K+ pale yellow-brown, salazinic acid absent 14

14. Medulla P+ red, protocetraric acid present 15
14. Medulla P–, protocetraric acid absent 17

15. Upper surface grey-green to yellow-grey; echinocarpic, ±usnic acid present . . . . *P. dilatatum*
15. Upper surface grey; echinocarpic and usnic acid absent 16

16. Lower medulla white, euplectin absent . . . . *P. gardneri*
16. Lower medulla orange-red, euplectin present . . . . *P. subochraceum*

17. Medulla C+ red, lecanoric acid present . . . . *P. austrosinense*
17. Medulla C–, lecanoric acid absent 18

18. Upper surface maculate, norlobaridone present (KC+ red) . . . . . *P. applanatum*
18. Upper surface emaculate, praesorediosic acid present (KC–) . . . . *P. praesorediosum*

KEY 2: Thallus with isidia or lobules

1.	Lobes distinctly ciliate	2
1.	Lobes eciliate or very sparsely ciliate	4
2.	Medulla K+yellow, stictic acid present	*P. crinitum*
2.	Medulla K–, stictic acid absent	3
3.	Isidia granular to inflated, medulla KC–, P+	*P. subcorallinum*
3.	Isidia sorediate in part, medulla KC+, P–	*P. mellisii*
4.	Medulla white, eumitrin derivatives absent	5
4.	Medulla yellow, eumitrin derivatives present	*P. sipmanii*
5.	Lobules present, isidia absent	*P. myriolobulatum*
5.	Isidia present, lobules present or absent	6
6.	Medulla C+ red, P–, lecanoric acid present	7
6.	Medulla P+ red, C–, protocetraric acid present	8
7.	Isidia slender, cylindrical	*P. tinctorum*
7.	Isidia inflated and/or irregular	*P. pseudotinctorum*
8.	Isidia slender, cylindrical, laminal	*P. saccatilobum*
8.	Isidia globose, inflated and/or irregular, submarginal	*P. incrassatum*

KEY 3: Thallus lacking soredia, isidia and lobules

1.	Lobes eciliate	2
1.	Lobes ciliate	3
2.	Medulla C+ red, P–, lecanoric acid present	*P. andinum*
2.	Medulla C–, P+ red, protocetraric acid present	*P. overeemii*
2.	Medulla C–, P–, KC+ red, alectoronic acid present	*P. crinitoides*
3.	Medulla yellow, secalonic acid A present	*P. immiscens*
3.	Medulla white, secalonic acid A absent	4
4.	Medulla K+ yellow, stictic acid present	*P. eciliatum*
4.	Medulla K–, stictic acid absent	5
5.	Medulla C+ rose, gyrophoric acid present	*P. eunetum*
5.	Medulla C–, gyrophoric acid absent	6
6.	Medulla P+ red, protocetraric acid present	*P. overeemii*
6.	Medulla P–, protocetraric acid absent	7
7.	Upper surface strongly maculate; apothecia perforate	*P. nilgherrense*
7.	Upper surface emaculate or weakly maculate; apothecia perforate or not	8
8.	Alectoronic acid present, lichesterinic acid absent; apothecia imperforate	*P. subrugatum*
8.	Alectoronic acid absent, lichesterinic acid present; apothecia perforate	*P. leave*

The Species

1. ***Parmotrema andinum*** (Müll.Arg.) Hale, Phytologia **28**: 334 (1974)
≡ *Parmelia andina* Müll.Arg., Rev. Mycol. **1**: 169 (1879).

This species is characterized by the eciliate lobes which lack soredia and isidia, and the production of lecanoric acid as the major metabolite in the medulla (K–, C+ red, P–). It is considered to be the fertile counterpart of the sorediate species, *P. austrosinensis* (Hale 1965).

Parmotrema andinum is mainly distributed in central and southern Africa and is much rarer in the tropical areas of South America and Asia (Hale 1965). New to China.

Specimen examined
CHINA. **Yunnan**, Yongping, *X.Y. Wang et al.* 1653-2.

2. ***Parmotrema applanatum*** Ribeiro & Marcelli, Mitt. Inst. Allg. Bot. Hamburg **30-32**: 145 (2002)

This species is characterized by the eciliate lobes with linear marginal soralia and granular soralia, and the presence of loxodin and norlobaridone in the medulla (K–, C–, KC+ red). It closely resembles the well-known *P. hababianum*, but differs from that species in lacking cilia and in containing traces of usnic acid as well as atranorin in the upper cortex. The medullary chemistry of the type specimen of *P. applanatum* was previously misdetermined (Marcelli & Ribeiro 2002).

Prior to the present work *P. applanatum* was known only from Brazil (Marcelli & Ribeiro 2002). New to China.

Specimens examined
CHINA. **Yunnan**, Lianghe, *X.Y. Wang et al.* 3177; Lushui, *X.Y. Wang et al.* 2160.

3. ***Parmotrema arnoldii*** (Du Rietz) Hale, Phytologia **28**: 335 (1974)
≡ *Parmelia arnoldii* Du Rietz, Nyt Mag. Naturv. **62**: 80 (1924).

This species is characterized by the presence of cilia, dentate marginal laciniae, revolute sorediate lobes with marginal soralia, and the presence of alectoronic acid, α-collatolic acid and ±skyrin in the medulla (KC–, C–, KC+ red, P–). *Parmotrema arnoldii* is similar to *P. sublatifolium*, but the latter species has smaller spores (13–15 × 7.5–8.6 μm cf. 15–22 × 9.5–12 μm) and contains bourgeanic and alectoronic acids. *Parmotrema arnoldii* differs from *P. rampoddense* in producing filiform conidia 10–14 μm long whereas the latter has rod-shaped conidia 5–6 μm long. *Parmotrema louisianae*, another similar species, differs in having a broad, white marginal band on the lower surface. These species can be confused because they are all ciliate, sorediate species which contain alectoronic acid and ±α-collatolic acid in the medulla.

Although *P. arnoldii* is common in Europe, North and Central America and the Caribbean, it is much more scattered in the Southern Hemisphere (Hale 1965). In China this species has been previously reported from Guangxi, Yunnan, Xizang and Taiwan (Wei 1991; Kurokawa & Lai 2001).

Specimens examined
CHINA. **Hainan**, Ledong, *Y.M. Jiang & S.Y. Guo* 557, 595. **Yunnan**, Simao, *J.D. Zhao & Y.B. Chen* 3057, 3185; Xichou, *J.B. Chen* 5149, 5283.

4. ***Parmotrema austrosinense*** (Zahlbr.) Hale, Phytologia **28**: 335 (1974)

≡ *Parmelia austrosinensis* Zahlbr. in Handel-Mazzetti, Simb. Sin. **3**: 192 (1930). Type: CHINA. Gwanyinschan near Kweiyang, Kweitschou, Yunnan, *Handel-Mazzetti 10580*; lecto: WU; isolecto: BPI, W, *fide* M. E. Hale, Contr. U.S. Natl Herb. **36**: 239 (1965).

This species is characterized by eciliate, sinuate lobes with marginal soralia, a black lower surface with a broad, mottled to ivory or pale brownish marginal zone and the presence of lecanoric acid in the medulla (K–, C+ rose, KC+ red, P–). It is distinguished from other eciliate, sorediate species in China by containing lecanoric acid.

Parmotrema austrosinense is widely distributed in tropical and temperate regions. In China this species has been reported previously from Guangxi, Guizhou, Jiangxi, Sichuan, Yunnan, Zhejiang (Wei 1991) and Taiwan (Kurokawa & Lai 2001).

Representative specimens examined

CHINA. **Guangxi**, Napo, *L.H. Chen* 980155, 980224. **Sichuan**, Qingchengshan, *Q.M. Ma* 705a. **Yunnan**, Gejiu, *J.D. Zhao & Y.B. Chen* 2308, 2486; Wenshan, *Q.Z. Wang* 979, 1004; Malipo, *J.B. Chen* 5456.

5. ***Parmotrema chinense*** (Osbeck) Hale & Ahti, Taxon **35**: 133(1986)

≡ *Lichen chinensis* Osbeck, Dagb. Ostind, Resa 221(1757).

=*Lichen perlatus* Huds., Fl. Angl. 448(1762); *Parmelia perlata* (Huds) Ach., Meth. Lich. 216 (1803); *Parmotrema perlatum* (Huds.) M.Choisy, Bull. Mens. Soc. Linn. Soc. Bot. Lyon **21**: 174 (1952).

This species is characterized by the ciliate lobes with revolute sorediate margins, and the presence of the stictic acid complex in the medulla (K+ yellow, C–, KC–, P+ orange). It is easily distinguished from morphologically similar sorediate species by the presence of stictic acid. The South American species, *P. bangii* (Vain) Hale, has cilia and contains stictic acid, but is distinguished by having sorediate pustules on upper surface of lobes rather than marginal soralia.

Parmotrema chinense is widespread in tropical and temperate areas (Elix 1994; Swinscow & Krog 1988). In China this species has been reported previously from Guangdong, Guangxi, Guizhou, Hainan, Hebei, Heilongjiang, Hubei, Jinlin, Liaoning, Shaanxi, Shangdong, Yunnan, Xianggang and Taiwan (Wei 1991).

Representative specimens examined

CHINA. **Hebei**, Mt. Wulingshan, *J.B. Chen & S.L. Wang* 73, 101, 107. **Heilongjiang**, Dailing, *J.B. Chen & G.R. Hu* 21998, 22010. **Hubei**, Shennongjia, *J.B. Chen* 12012, 12136. **Hunan**, Sangzhi, *J.B. Chen* et al. 9756, 9993. **Jilin**, Mt. Changbai, *J.B. Chen* & S.L. Wang 13075, 14165; Jiaohe, *J.B. Chen & Y.M. Jiang* 1105, 1137. **Sichuan**, Wenchuan, *X.Y. Wang* et al. 9838.

6. ***Parmotrema crinitoides*** C.J. Wei, Enum. Lichens in China 177 (1991)

≡ *Parmelia proboscidea* var. *eciliata* Zhao, Acta Phytotax. Sin. **9**: 164 (1964).Type: CHINA. Yunnan, *Poliyangskii* 1003, 24 April 1957 (holo: HMAS-L).

This species is characterized by lobes with eciliate or rarely very sparsely ciliate margins, the absence of soredia and isidia and the presence of alectoronic acid in the medulla (K–, C–, KC+ red, P–). All other eciliate, esorediate, non-isidiate species of

Parmotrema in China lack alectoronic acid. In many respects this species resembles *P. pancheri* (Hue) Hale but differs in having a thinner, more membranaceous thallus (thick and coriaceous in *P. pancheri*), imperforate apothecia (perforate in *P. pancheri*) and shorter, weakly sublageniform conidia (5–8 μm cf. 8–10 μm long).

At present *P. crinitoides* is only known from the type locality.

Specimen examined

CHINA. **Yunnan**, *Poliyangskii* 1008 (CANB, HMAS-L).

7. *Parmotrema crinitum* (Ach.) M.Choisy, Bull. Mens. Soc. Linn. Soc. Bot. Lyon **21**: 175 (1952)

≡ *Parmelia crinita* Ach., Syn. Meth. Lich. 196 (1814).

= *Parmelia proboscidea* Tayl., Fl. Hibern. **2**: 143 (1836).

This species is characterized by lobes with ciliate margins, dense isidia which are often ciliate at the apices and the presence of the stictic acid complex in the medulla (K+ yellow, C–, KC–, P + orange). Other isidiate species of *Parmotrema* in China lack stictic acid.

Parmotrema crinitum is widely distributed in temperate and tropical regions (Hale 1965; Elix 1994). In China this species has been previously reported from Liaoning, Shaanxi, Yunnan and Taiwan (Wei 1991; Kurokawa & Lai 2001).

Specimens examined

CHINA. **Sichuan**: Dujiangyan, *J.C. Wei* 97054; Jiuzhaigou, *J.B. Chen* 6057-2; Wenchuan, *X.Y. Wang* et al. 9820. **Yunnan**, Xichou, *J.B. Chen* 5024-1; Ruili, *X.Y. Wang et al.* 329-1. **Zhejiang**, *C. Ding* 8124.

8. *Parmotrema cristiferum* (Taylor) Hale, Phytologia **28**: 335 (1974)

≡ *Parmelia cristifera* Taylor, London J. Bot., 6: 165 (1847).

= *Parmelia mesotropa* Müll. Arg. f. *sorediosa* Müll Arg., Flora **74**: 377 (1891).

= *Parmelia cristifera* f. *cinerata* Zahlbr. Repert. Spec. Nov. Regni Veg. **33**: 58 (1934). Type: Kuwarus, Taiwan, *Y. Asahina* 51 (W, holotype; BPI isotype).

This species is characterized by the eciliate lobes with ascending margins and marginal soralia, and the presence of salazinic acid and consalazinic acid in the medulla (K+ yellow turning red, C–, P + orange red). It is the only eciliate, sorediate species in China which contains salazinic acid.

Parmotrema cristiferum is widely distributed in tropical and subtropical regions (Hale 1965; Elix 1994). In China this species has been reported previously from Hainan, Yunnan (Wei 1991) and Taiwan (Hale 1965; Kurokawa & Lai 2001).

Representative specimens examined

CHINA. **Guizhou**, Ceheng, *Q.Z. Wang* 623. **Hainan**, Mt. Wuzhishan, *J.B. Chen* 2055-1, 20573. **Yunnan**, Xishuangbanna, Mengyang, *J.D. Zhao & Y.B. Chen* 3570, 3574; *J.B. Chen* 5527, 5547.

9. *Parmotrema deflectens* (Kurok.) Streim., Biblioth. Lichenol. **22**: 93 (1986)

≡ *Parmelia deflectens* Kurok., Studies Crypt. Papua New Guinea 130 (1979).

This species is characterized by the ciliate lobes with linear marginal soralia, and the presence of alectoronic, ±α-collatolic and protocetraric acids in the medulla. In China two other species have ciliate, sorediate lobes, and contain protocetraric acid, namely *P. dilatatum* and *P. subarnoldii*. However, both lack alectoronic acid. In addition to protocetraric acid, *P. dilatatum* contains echinocarpic acid and ±usnic acid, whereas *P. subarnoldii* contains protolichesterinic acid and ±skyrin. Futhermore, *P. deflectens* has granular rather than farinose soredia, and pruina near margins of lobes. Krog & Swinscow (1981) considered *P. deflectens* to be a chemotype of *P. subarnoldii*, but we consider it a distinct species in the present paper.

Parmotrema deflectens is known from montane tropical areas of Papua New Guinea (Kurokawa 1979; Louwhoff & Elix 1999) and East Africa (Krog & Swinscow 1981). New to China.

Specimens examined

CHINA. **Yunnan**, Xishuangbanna, Mengyang, *J.D. Zhao & Y.B. Chen* 3745; Weixi, *J.J. Su* 44-1.

10. ***Parmotrema dilatatum*** (Vain.) Hale, Phytologia **28**: 335 (1974)
≡ *Parmelia dilatata* Vain., Acta Soc. Fauna Fl. Fenn. **7**: 33 (1890).

This species is characterized by the yellowish to grey upper surface, eciliate or ciliate lobes, linear marginal to subcapitate soralia with granular soredia, and the presence of echinocarpic, protocetraric, ±usnic and ±secalonic acids in the medulla (K+ yellow brown, C–, KC+ reddish, P+ brick-red). The development of cilia in this species varies from distinct to sparse or absent (Hale 1965). The Chinese specimens lack cilia and closely resemble *P. cristiferum* in morphology, but can be distinguished by the presence of protocetraric acid rather than salazinic acid in the medulla.

Parmotrema dilatatum is a pantropical species known from Africa, India, South America, Papua New Guinea, Australia, New Zealand and the Pacific (Elix 1994; Hale 1965; Krog & Swinscow 1981; Louwhoff & Elix 1999). In China this species has previously been recorded from Taiwan (Kurokawa & Lai 2001), but is now reported from mainland China for the first time.

Representative specimens examined

CHINA. **Hainan**, Ledong County, *Y.M. Jiang & S.Y. Guo* 729; Mt. Wuzhi, *J.B. Chen et al.* 20555, 20577. **Yunnan**, Simao, *J.D. Zhao & Y.B. Chen* 3725; *Baliangsiji*, Apr. 1957; Xishuangbanna, *J.B. Chen* 5513.

11. ***Parmotrema eciliatum*** (Nyl.) Hale, Phytologia **28**: 336 (1974)
≡ *Parmelia crinita* var. *eciliata* Nyl., Flora **52**: 291 (1869); *Parmelia eciliata* (Nyl.) Nyl., Mexic. Pl. **1**: 3 (1872).

This species is characterized by the ciliate lobes with crenulate margins, the lack of soredia and isidia, simple to dichotomously branched rhizines, and the presence of stictic acid complex in the medulla (K+ yellow, C–, KC–, P+ orange-red). Chemically it is very similar to *P. chinense* and *P. crinitum*, but *P. chinense* is distinguished by the presence of soredia and *P. crinitum* by the presence of isidia. Kurokawa & Lai (2001) pointed out that *P. eciliatum* possibly represents the parent morph of the sorediate *P. chinense* and the isidiate *P. crinitum*.

Parmotrema eciliatum is known from Central and South America, East and South Africa, Japan and Australia (Hale 1965; Elix 1994). In China this species has been reported previously form Anhui, Zhejiang (Wei 1991) and Taiwan (Kurokawa & Lai 2001).

Specimens examined
CHINA. **Anhui**, Mt. Huangshan, *J.B. Chen* 14743. **Fujian**, Mt. Wuyi, *X.Q. Gao* 2793. **Hubei**, Shennongjia, *J.B. Chen* 10087-2. **Hunan**, Zhangjiajie, *J.B. Chen et al.* 9357. **Zhejiang**, Longquan, *Z.G. Qian* 6233-1.

12. ***Parmotrema eunetum*** (Stirt.) Hale, Phytologia **28**: 336 (1974)
≡ *Parmelia euneta* Stirt., Scott. Nat. **4**: 298 (1877).

This species is characterized by the ciliate lobes with entire to crenate margins, a faintly maculate upper surface, the absence of soredia and isidia, perforate discs with a ciliate exciple, and the presence of medullary gyrophoric acid (K–, C+ rose, KC+ red, P–). In China *P. eunetum* can be readily distinguished from similar species by the presence gyrophoric acid in the medulla (C+ rose). The Chinese specimen examined lacks apothecia and distinct maculae on the upper surface.

Parmotrema eunetum appears to be a pantropical species, although it is rare outside of Africa (Hale 1965). New to China.

Specimen examined
CHINA. **Yunnan**, Simao, *J.D. Zhao & Y.B. Chen* 3640.

13. ***Parmotrema gardneri*** (Dodge) Sérus., Bryologist **87**: 5 (1984)
≡ *Parmelia gardneri* Dodge, Ann. Missouri Bot. Gard. **46**: 179 (1959).

This species is characterized by the eciliate lobes with marginal soralia, and the presence of protocetraric acid in the medulla (K–, C–, KC+ red, P+ red). Although it was reduced to synonymy with *Parmelia cristifera* (= *Parmotrema cristiferum*) by Hale (1965), the latter is distinguished by the presence of medullary salazinic acid.

Parmotrema gardneri is a pantropical species known from Africa, South America, Australia, Papua New Guinea and the Pacific (Elix 1994; Louwhoff & Elix 1999). New to China.

Specimens examined
CHINA. **Yunnan**, Simao, *J.D. Zhao & Y.B. Chen* 2897, 3058.

14. ***Parmotrema grayanum*** (Hue) Hale, Phytologia **28**: 336 (1974)
≡ *Parmelia grayana* Hue, Nouv. Arch. Mus. Paris, ser. 4, **1**: 184 (1899).
= *Parmelia simodensis* Asahina, J. Jap. Bot. **17**: 73 (1941).

This species is characterized by the ciliate lobes with ascending margins, marginal and submarginal soredia often with a grey-brown tinge, and the presence of lichensterinic and protolichesteric acids in the medulla (K–, C–, KC–, P–).

Parmotrema grayanum is a saxicolous species known from Africa, Asia (Hale 1965), North America, New Zealand and Australia (Elix 1994). In China it has been previously reported form Anhui, Jiangxi, Jilin, Xizang and Yunnan (Wei 1991), but we have only encountered one authentic specimen of this species in the present investigation.

Specimen examined
CHINA. **Xizang**, Zham, *J.C. Wei & J.B. Chen* 601.

15. *Parmotrema immiscens* (Nyl.) Kurok., Bull. Bot. Gard. Toyama, **2**: 42 (1997)
≡ *Parmelia immiscens* Nyl., Flora **68**: 606 (1885); *Parmelina immiscens* (Nyl.) Hale, Phytologia **28**: 482 (1974); *Myelochroa immiscens* (Nyl.) Elix & Hale, Mycotaxon **29**: 241 (1987).

This species is characterized by the narrow lobes (2–5 mm wide) with most cilia confined to the axils, the lack of vegetative propagules, and a sulfur-yellow medulla containing secalonic acid A and eumitrins F and G (K–, C–, KC–, P–). As the medullary pigments and narrow lobes are similar to those of *Myelochroa* species, Elix & Hale (1987) transferred *P. immiscens* from *Parmelina* to *Myelochroa*. However, this species does not produce zeorin and related triterpenoids which are characteristic of *Myelochroa*. In addition, *P. immiscens* has a broader, naked zone on the lower surface near the apices than do most *Myelochroa* species. As a consequence, Kurokawa & Arakawa (1997) transferred this species to *Parmotrema*.

Parmotrema immiscens was previously known only from Mexico (Hale 1976). New to China.

Specimens examined

CHINA. **Yunnan**, Lushui, *X.Y. Wang et al.* 2416, 2523.

16. *Parmotrema incrassatum* Hale ex DePriest & B. W. Hale, Mycotaxon **67**: 207 (1998)
Type: CHINA. Xianggang (Hong Kong), Soko Island, on granite boulder along shore on N side of island, 1 June 1975, *Stella L. Thrower 2220*; holo: US!

This species is characterized by eciliate lobes with numerous submarginal isidia, isidia which are globose, irregularly inflated or coralloid-distorted with pale, syncorticate apices and by the presence of protocetraric acid in the medulla (K–, C–, KC+ pink, P+ red). It is most likely to be confused with the chemically identical *P. saccatilobum,* but the latter is distinguished by its short, laminal, cylindrical isidia with blackened, syncorticate apices.

At present this species is known from Hong Kong and Thailand (Thrower 1988; DePriest & Hale 1998; Pooprang *et al.* 2000).

17. *Parmotrema laeve* (Zhao) J.B. Chen & Elix, comb. nov.
Basionym: *Parmelia yunnana* var. *laevis* Zhao, Acta Phytotax. Sin. **9**: 163 (1964). Type: CHINA. Yunnan, Simao, on bark of trees, Nov. 1960, *J.D. Zhao & Y.B. Chen* 3648 (holo: HMAS-L).

This species is characterized by ciliate lobes, the absence of soredia, isidia and maculae on the upper surface, the perforate apothecia, and the presence of lichesterinic and protolichesterinic acids in the medulla (K–, C–, KC–, P–). Wei (1991) treated this taxon as a synonym of *P. nilgherrense*. However, *P. nilgherrense* differs in having a strongly maculate upper surface and in containing alectoronic acid in the medulla (KC+ red). In overall morphology *P. laeve* resembles *P. subrugatum* as both lack vegetative propagules, have ciliate lobes with an emaculate upper surface but apothecia with a maculate exciple. However, *P. subrugatum* has imperforate apothecia, marginal laciniae and contains medullary alectoronic and α-collatolic acids. At present *P. laeve* is known only from the type locality. It probably represents the fertile, esorediate counterpart of *P. grayanum.*

18. *Parmotrema louisianae* (Hale) Hale, Phytologia **28**: 337 (1974)
≡ *Parmelia louisianae* Hale, Phytologia **22**: 92 (1971).

This species is characterized by ciliate, sinuate lobes with submarginal soralia, a lower surface which is black in the centre but with a broad, mottled to ivory or pale tan marginal zone and the presence of alectoronic, ±α-collatolic acids in the medulla (K–, C–, KC+ red, P–). It is distinguished from other ciliate, sorediate species in China containing alectoronic acid, by the broad, ivory to pale tan marginal zone on the lower surface.

Parmotrema louisianae has been reported previously from North America (Hale 1971) and Kenya (Krog & Swinscow 1981). New to China.

Specimens examined
CHINA. **Guangxi**, Jingxi, *L.H. Chen* 980244. **Hainan**, Ledong, *J.B. Chen et al.* 20802.

19. *Parmotrema margaritatum* (Hue) Hale, Phytologia **28**: 337 (1974)
≡ *Parmelia margaritata* Hue, Nouv. Arch. Mus. Paris, sér. 4, **1**: 193 (1898).

This species is characterized by the ciliate lobes with marginal laciniae and soralia, and the presence of salazinic acid in the medulla (K+ yellow turning red, C–, KC–, P+ orange-red). Among the *Parmotrema* species with cilia and soredia in China, *P. margaritata* is the only species which contains salazinic acid. *Parmotrema cristiferum* is also sorediate and contains salazinic acid but it lacks cilia.

Previously *P. margaritatum* was only known from North America (Hale 1965). It seems to be a further example of the East Asian-North America distribution pattern. New to China.

Specimens examined
CHINA. **Hainan**, Changjiang, *Y.M. Jiang & S.Y. Guo* 312. **Yunnan**, Menghai, *J.B. Chen* 6547-2.

20. *Parmotrema mellissii* (Dodge) Hale, Phytologia **28**: 337 (1974)
≡ *Parmelia mellissii* Dodge, Ann. Missouri Bot. Gard. **46**: 134 (1959).

This species is characterized by lobes with abundant cilia, marginal isidia which are often sorediate and ciliate, and the presence of alectoronic and α-collatolic acids in the medulla (K–, C–, KC+ red, P–). Hale (1965), Elix (1994) and Kurokawa & Lai (2001) reported that the lower half in the medulla of *P. mellissii* is often orange-colored due to the presence of skyrin, but so far this has not been observed in the Chinese specimens we have examined.

Parmotrema mellissii is a pantropical species with northward extensions into temperate North America and Japan (Hale 1965) and with southward extensions into Australia and New Zealand (Elix 1994). In China, this species has been previously reported from Anhui, Yunnan, Zhejiang (Wei 1991) and Taiwan (Kurokawa & Lai 2001).

Representative specimens examined
CHINA. **Fujian**, Mt. Wuyi, *J.B. Chen & S.L. Wang* 14116, 14284. **Hainan**, Mt. Wuzhishan,

Y.M. Jiang & S.Y. Guo 1064. **Hunan**, Mt. Mangshan, *J.B. Chen et al.* 20730. **Yunnan**, Xichou, *J.B. Chen* 5259. **Zhejiang**, Taishun, *Z.G. Qian* 5630; Longquan, *Z.G. Qian* 6521.

21. *Parmotrema myriolobulatum* (Zhao) J.C. Wei, Enum. Lichens in China 178 (1991)

≡ *Parmelia myriolobulata* Zhao, Acta Phytotax. Sin. **9**: 165 (1964). Type: CHINA. Yunnan, Mengyang *J.D. Zhao & Y.B. Chen* 3579, 24 Nov. 1960 (holo: HMAS-L).

This species is characterized by eciliate lobes with numerous marginal lobules, the absence of soredia and isidia, imperforate apothecia, and the presence of protocetraric acid in the medulla (K–, C–, KC+ pink, P+ red). It is very similar to *P. merrillii* (Vain.) Hale in morphology and chemistry, but the exciple of the apothecia in *P. merrillii* bears laciniae and cilia (these are absent in *P. myriolobulatum*). Furthermore, the ascospores of *P. merrillii* are larger (26–34 × 12–16 μm) than those of *P. myriolobulatum* (20–25 × 10–13 μm) .

At present *P. myriolobulatum* is only known from China.

Specimens examined

CHINA. **Yunnan**, Mengyang, *J.D. Zhao & Y.B. Chen* 3573 3579, 3587, 3627; Simao, *J.D. Zhao & Y.B. Chen* 3551, 3649, 3695a.

22. *Parmotrema nilgherrense* (Nyl.) Hale, Phytologia **28**: 338 (1974)

≡ *Parmelia nilgherrensis* Nyl., Flora **52**: 291 (1869).

= *Parmelia yunnana* Hue, Nouv. Arch. Mus. Paris, sér. 4, **1**: 186 (1899).

= *Parmelia yunnana* var. *yunnana* f. *subnuda* Zahlbr., Hedwigia **74**: 210 (1934).

This species is characterized by the ciliate lobes, the strongly maculate upper surface, the absence of soredia and isidia, the dark brown to black marginal zone on the lower surface, the perforate apothecia and the presence of alectoronic, ±α-collatolic acids in the medulla (K–, C–, KC+ red, P–). *Parmotrema subrugatum* is similar but has imperforate discs with ciliate margins and is only maculate on the thalline exciple. *Parmotrema nilgherrense* is distinguished from *P. pseudonilgherrense* by the presence of soredia. The pycnidia in Chinese specimens of this species are both marginal and laminal, although pycnidia are typically only laminal in most *Parmotrema* species.

Parmotrema nilgherrense is a typical Asian species which is very common in the foothills of the Himalayan mountains (Hale 1965) but also occurs in Sri Lanka, East Africa (Krog & Swinscow 1981) and Papua New Guinea (Louwhoff & Elix 1999). In China this species has been reported previously from Shaanxi, Yunnan, Xizang and Taiwan (Wei 1991), but the occurrence of this species in Taiwan is uncertain (Kurokawa & Lai 2001).

Representative specimens examined

CHINA. **Yunnan**, Lijiang, *J.D. Zhao & Y.B. Chen* 4347, 4355, 4548; Lushui, *X.Y. Wang et al.* 2607, 2702. **Xizang**, Zhangmu, *J.C. Wei & J.B. Chen* 403, 495, 568.

23. *Parmotrema overeemii* (Zahlbr.) Elix, Australas. Lichenol. **42**: 23 (1998)

≡ *Parmelia overeemii* Zahlbr., Ann. Crypt. Exot. **1**: 204 (1928).

= *Parmelia subtropica* Zhao, Acta Phytotax. Sin. **9**: 165 (1964). *Parmotrema*

subtropicum (Zhao) C.J. Wei, Enum. Lichens in China 181 (1991).
Type: CHINA. Yunnan, Xishuangbanna, Xujinghong, *Poliyangskii* 1004, 10 June 1957 (holo: HMAS-L).

This species is characterized by eciliate lobes or by lobes with sparse, short cilia, the absence of soredia and isidia, the imperforate apothecia, and the presence of protocetraric acid (±traces of virensic acid) in the medulla (K–, C–, KC+ pink, P+ red). Hale (1965) considered this species to be a synonym of *P. zollingeri*, but the latter contains succinprotocetraric and fumarprotocetraric acids rather than protocetraric acid (Elix 1998).

Parmotrema overeemii has been reported previously from East Africa, Indonesia, Thailand, Australia, Papua New Guinea, the Pacific (Elix 1998; Louwhoff & Elix 1999) and Taiwan (Kurokawa & Lai 2001).

Specimens examined

CHINA. **Hainan**, Mt. Wuzhi, *Y.M. Jiang & S. Y. Guo* 1001-1. **Yunnan**, Xishuangbanna, *S.J. Han & L.Y. Chen* 5379; *S.Y. Guo* 94840.

24. *Parmotrema permutatum* (Stirt.) Hale, Phytologia **28**: 338 (1974)
≡ *Parmelia permutata* Stirt., Scott. Nat. **4**: 252 (1877).

This species is characterized by the ciliate lobes with elongate, marginal soralia, the medulla which is white in the upper half and yellow-orange in lower half, and the presence of gyrophoric acid and eumitrins N1, N2 and related pigments in the medulla (K–, C+ rose, KC+ red, P–; pigments K–). *Parmotrema sancti-angelii* is another ciliate, sorediate species which produces gyrophoric acid and may have a yellow-orange pigmented medulla, but there the pigment is skyrin (K+ purple). Another similar species with a yellow medulla, *P. conjunctum* Hale, lacks cilia.

Parmotrema permutatum is known from Africa, Australia, India, Indonesia, Papua New Guinea, Haiti, Brazil (Elix 1994; Hale 1965; Louwhoff & Elix 1999) and Taiwan (Kurokawa & Lai 2001). New to mainland China.

Specimens examined

CHINA. **Yunnan**, Simao, *J.D.Zhao & Y.B. Chen* 2535, 3703.

25. *Parmotrema praesorediosum* (Nyl.) Hale, Phytologia **28**: 338 (1974)
≡ *Parmelia praesorediosa* Nyl., Sert. Lich. Trop. 18 (1891).
= *Parmelia neglecta* Asahina, J. Jap. Bot. **17**: 71 (1941).
= *Parmelia perlata* sensu Zahlbr., Repert. Spec. Nov. Regni Veg. **33**: 58 (1933), non *Parmelia perlata* (Huds.) Ach.

This species is characterized by the eciliate lobes with sorediate margins, crescent-shaped or subcapitate soralia and the presence of praesorediosic and protopraesorediosic acids in the medulla (K–, C–, KC–, P–). It is distinguished from other related eciliate sorediate species in China by medullary chemistry: *P. austrosinense* contains lecanoric acid (C+ red); *P. cristiferum* contains salazinic acid (K+ red); and *P. dilatatum* contains protocetraric acid (P+ red).

Parmotrema praesorediosum is a pantropical species, known from Africa, America, India, Indonesia, Papua New Guinea, New Caledonia, Fiji and Australia (Elix 1994;

Hale 1965; Louwhoff & Elix 1999). In China this species has been reported previously from Guizhou, Jilin, Liaoning, Xianggang, Zhejiang (Wei 1991) and Taiwan (Kurokawa & Lai 2001).

Representative specimens examined

CHINA. **Guangxi**, Napo, *L.H. Chen* 980349, 980356. **Guizhou**, Ceheng County, *Q.Z. Wang* 602a. **Hong Kong**, *S.L. Thrower* 3058. **Yunnan**, Xishuangbanna, *J.B. Chen* 5481, 6492.

26. *Parmotrema pseudonilgherrense* (Asahina) Hale, Mycotaxon **5**: 441 (1977)
≡ *Parmelia pseudonilgherrensis* Asahina, J. Jap. Bot. **29**: 370 (1954).
Type: CHINA. Jilin, Mt. Hokusui-Hakusan, Kankyo-Nando, *U. Tsutani s.n.,* 13 Aug. 1936 [lecto: TNS, *fide* H. Krog & T. D. V. Swinscow, Bull. Brit. Mus. (Nat. Hist.) Bot. 9: 192 (1981)].

This species is similar to *P. nilgherrense* but differs in being sorediate; it is considered to be the sorediate counterpart of *P. nilgherrense*. Morphologically *P. lobulascens* (Steiner) Hale is identical with *P. pseudonilgherrense*, but *P. lobulascens* contains additional gyrophoric acid. Krog & Swinscow (1981) reduced the present species to synonymy with *P. lobulascens*, but we have maintained *P. pseudonilgherrense* as a separate species in the present paper.

Parmotrema pseudonilgherrense is known from Africa, India, Nepal, Korea (Hale 1965) and Australia (Elix 1994). In China this species has been reported previously from Hubei, Jilin, Xizang (Wei 1991) and Taiwan (Kurokawa & Lai 2001; as *P. lobulascens*).

Representative specimens examined

CHINA. **Hebei**, Mt. Wulingshan, J.B. *Chen & S.L. Wang* 62, 85. **Hubei**, Shennongjia, *J.B. Chen* 11925. **Jilin**, Mt. Changbaishan, *J.B. Chen & S.L. Wang* 14019, 14099. **Shaanxi**, Taibaishan, *C.H. Ma* 125. **Sichuan**, Maerkang, *X.Y. Wang & X. Xiao* 11373, 11408. **Xizang**, Nyalam, *J.C. Wei & J.B. Chen* 818, 893. **Yunnan**, Deqin, *J.J, Su* 5563.

27. *Parmotrema pseudotinctorum* (des Abbayes) Hale, Phytologia **28**: 338 (1974)
≡ *Parmelia pseudotinctorum* des Abbayes, Bull. Inst. Fr. Afr. Noire, **13**: 973 (1951).

This species is characterized by eciliate lobes, large, irregular and inflated isidia (*ca.* 0.2 mm wide), and the presence of lecanoric acid in the medulla (K–, C+ red, KC+ red, P–). This species is identical with *P. tinctorum* in habit and chemistry, but differs chiefly in having large inflated isidia, whereas *P. tinctorum* has uniformly thin cylindrical or even granular isidia. Kurokawa & Lai (2001) reduced this species to synonymy with *P. tinctorum*, but they are considered to be distinct species in the present paper .

Parmotrema pseudotinctorum has been reported previously from Africa (Hale 1965). New to China.

Specimen examined

CHINA. **Yunnan**, Kunming, *J.B. Chen* 6480.

28. *Parmotrema rampoddense* (Nyl.) Hale, Phytologia **28**: 338 (1974)
≡ *Parmelia rampoddensis* Nyl., Acta Soc. Sci. Fenn. **26**: 7 (1900).

This species is characterized by the ciliate lobes with linear marginal or subcapitate soralia, where the sorediate lobes become revolute, and by the presence of alectoronic and α-collatolic acids, ±skyrin (orange) in the lower medulla and/or fusarubin and anhydrofusarubin lactol (purple) in the cilia.

Parmotrema rampoddense is a pantropical species which extends into temperate areas except for Europe (Elix 1994; Hale 1965; Louwhoff & Elix 1999). In China this species has been reported previously from Shaanxi (Jatta 1902; Zahlbruckner 1930) and Taiwan (Hale 1965; Kurokawa & Lai 2001).

Representative specimens examined

CHINA. **Guangxi**, Longsheng, *J.B. Chen et al.* 20074. **Hainan**, Lingshui, *J.B. Chen et al.* 20525; Mt. Wuzhishan, *J.B. Chen et al.* 20628. **Xizang**, Zogang, *J.J. Su* 5293. **Yunnan**, Simao, *J.D. Zhao & Y.B. Chen* 2516. **Zhejiang**, *Z.G. Qian* 6271.

29. ***Parmotrema saccatilobum*** (Taylor) Hale, Phytologia **28**: 339 (1974)
≡ *Parmelia saccatiloba* Taylor, London J. Bot. **6**: 174 (1847).
= *Parmelia inactiva* (Zahlbr.) Vain., Bot. Mag. Tokyo **35**: 47 (1921); *Parmelia tinctorum* var. *inactiva* Zahlbr., Denschr. Akad. Wiss. Naturw. Wien **81**: 271 (1908).

This species is characterized by the eciliate lobes with short, cylindrical isidia on the upper surface, isidia which often become dark at the apices, and by the presence of medullary protocetraric acid (K–, C–, KC+ pink, P+ red). *Parmotrema saccatilobum* is distinguished from *P. subcorallinum* by its eciliate lobes, and from *P. tinctorum* by the presence of protocetraric rather than lecanoric acid.

Parmotrema saccatilobum is known from the Pacific, Australia, India, Singapore (Elix 1994; Elix & McCarthy 1998; Hale 1965; Louwhoff & Elix 1999) and Taiwan (Kurokawa & Lai 2001). It has previously been reported for mainland China by Zhao (1964), based on a single specimen from Anhui [identified as *Parmelia tinctorum* var. *inactiva* Zahlbr.]. Although this identification was incorrect, authentic *P. saccatilobum* from mainland China is reported in the present paper.

Representative specimens examined

CHINA. **Hainan**, Lingshui, *J.B. Chen et al.* 20522, 20537; Mt. Wuzhishan, *J.B. Chen* 20601. **Yunnan**, Xichou, *J.B. Chen* 5182.

30. ***Parmotrema sancti-angelii*** (Lynge) Hale, Phytologia **28**: 339 (1974)
≡ *Parmelia sancti-angelii* Lynge, Ark. Bot. **13**: 35 (1914).

This species is characterized by the ciliate lobes with linear soralia, and the presence of gyrophoric acid in the medulla (K–, C+ rose, KC+ red, P–). Collections of this species from other regions sometimes contain the pigment skyrin (K+ purple) in the lower medulla, but this was not observed in Chinese specimens examined. Both *P. sancti-angelii* and *P. permutatum* contain gyrophoric acid (medulla C+ red) and have ciliate lobes with a sorediate upper surface, but *P. permutatum* has a yellow lower medulla due to the presence of eumitrin derivatives (K–).

Parmotrema sancti-angelii is a pantropical species known from Africa, Central and South America, Australia and Papua New Guinea (Elix 1994; Hale 1965; Krog & Swinscow 1981; Louwhoff & Elix 1999). In China this species has been reported previously from Xizang (Wei & Jiang 1986) and Taiwan (Kurokawa & Lai 2001).

Representative specimens examined

CHINA. **Guangxi**, Jingxi, *L.H. Chen* 980413, 980418. **Xizang**, Zhangmu, *J.C. Wei & J.B. Chen* 362. **Yunnan**, Simao, *J.D. Zhao & Y.B. Chen* 3068, 3152; Xichou, *J.B. Chen* 5295, 5375.

31. *Parmotrema sipmanii* Louwhoff & Elix, Biblioth. Lichenol. **73**: 115 (1999)

This species is characterized by the eciliate lobes, laminal to submarginal cylindrical isidia, the yellow medulla and the presence of eumitrin pigments (K–, C–, KC–, P–). It is distinguished from *P. endosulphureum* (Hillm.) Hale by the absence of gyrophoric acid in the medulla. *Parmotrema permutatum* also contains gyrophoric acid and eumitrin derivatives, but has ciliate lobes with a sorediate upper surface.

Only one small specimen of *P. sipmanii* from China has been examined, but it is identical with the type. Previously *P. sipmanii* was only known from the type locality, Motupore Island in Papua New Guinea (Louwhoff & Elix 1999). New to China.

Specimen examined

CHINA. **Fujian**, Mt. Wuyi, *J.B. Chen & S.L. Wang* 14518.

32. *Parmotrema subarnoldii* (des Abbayes) Hale, Phytologia **28**: 339 (1974)

≡ *Parmelia subarnoldii* des Abbayes, Mem. Inst. Sci. Madag. ser. B, **10**: 113 (1961).

This species is characterized by conspicuous cilia (up to 6 mm long), linear marginal soralia, and the presence of protocetraric acid in the medulla (K–, C–, KC+ pink, P+ brick-red). It differs from *P. arnoldii* in containing protocetraric acid rather than alectoronic acid. Among the ciliate, sorediate species of *Parmotrema* in China, *P. deflectens* and *P. dilatatum* also contain protocetraric acid, but *P. deflectens* contains additional alectoronic acid while *P. dilatatum* contains additional echinocarpic acid and ±usnic acid.

Parmotrema subarnoldii is a scattered pantropical species known from southern Africa, Madagascar, Indonesia, Papua New Guinea, Australia, Mexico and South America (Elix 1994; Hale 1965; Louwhoff & Elix 1999). New to China.

Specimens examined

CHINA. **Hainan**, Ledong, *Y.M. Jiang & S.Y. Guo* 548. **Yunnan**, Simao, *J.D. Zhao & Y. B. Chen* 3340; Menghai, *J.B. Chen* 6548

33. *Parmotrema subcorallinum* (Hale), Phytologia **28**: 339 (1974)

≡ *Parmelia subcorallina* Hale, J. Jap. Bot. **37**: 345 (1962).

Type: CHINA. Keitau, Taichu, Taiwan (Formosa), *Y. Asahina* 3312, Dec. 24 1933 (holo: TNS; iso: US).

This species is characterized by the ciliate lobes with dissected, isidiate margins, granular to cylindrical isidia which are often apically ciliate, and the presence of protocetraric and protolichesterinic acids in the medulla (K–, C–, KC+ reddish, P+ red). It resembles *P. crinitum* but the latter species contains the stictic acid complex.

Parmotrema subcorallinum is known from Indonesia, Mauritius, Taiwan (Hale 1962, 1965; Kurokawa & Lai 2001) and Papua New Guinea (Louwhoff & Elix 1999). This is the first report of this species from mainland China.

Specimens examined

CHINA. **Hainan**, Changjiang, *Y.M. Jiang & S.Y. Guo* 420; Ledong, *Y.M. Jiang & S.Y. Guo* 570-1, 721, 728.

34. ***Parmotrema sublatifolium*** (Zhao, Hsu & Sun) Wei, Enum. Lichens in China 180 (1991)

≡ *Parmelia sublatifolia* Zhao, Hsu & Sun, Acta Phytotax. Sin. **16**: 96 (1978).
Type: CHINA. Yunnan, Simao, *J.D. Zhao & Y.B. Chen* 3187 (holo: HMAS-L).

This species is characterized by the ciliate lobes with dentate marginal laciniae, linear to subcapitate soralia, and the presence of alectoronic and bourgeanic acids in the medulla (K–, C–, KC+ pink, P–; note that a KC– medullary reaction was recorded in the original description of this species but this is incorrect). *Parmotrema sublatifolium* differs from the morphologically similar *P. arnoldii* in having smaller spores (13–15 × 7.5–8.6 μm cf. 15–22 × 9–12 μm) and in containing additional bourgeanic acid.

At present *P. sublatifolium* only known from Yunnan in China (Zhao *et al.* 1978).

Specimens examined

CHINA. **Yunnan**, Simao, *J.D. Zhao & Y.B. Chen* 2907, 3187.

35. ***Parmotrema subochraceum*** Hale, Biblioth. Lichenol. **38**: 117 (1990)

This species is characterized by the eciliate lobes, the irregular, marginal to submarginal soralia, the orange–red lower medulla and the presence of protocetraric acid, euplectin and coneuplectin in the medulla (K–, C–, KC+ pink, P+ red; pigmented medulla K+ purple).

Previously *P. subochraceum* was known only from Brazil (Hale 1990). New to China.

Specimen examined

CHINA. **Yunnan**, Simao, *J.D. Zhao & Y.B. Chen* 3788.

36. ***Parmotrema subrugatum*** (Kremp.) Hale, Phytologia **28**: 339 (1974)

≡ *Parmelia subrugata* Kremp., Verh. K. K. Zool.-Bot. Ges. Wien **18**: 320 (1868).
= *Parmelia sinensis* Hue, Nouv. Arch. Mus. Paris, sér. 4, **1**: 187 (1899).

This species is characterized by the ciliate lobes with ±ascending laciniae, the absence of soredia and isidia, imperforate apothecia with a strongly rugose, maculate, dentate-laciniate, ciliate exciple, and the presence of alectoronic acid, α-collatolic acid, ±skyrin in the medulla (K–, C–, KC+ red, P–). It resembles *P. nilgherrense,* but the latter has a strongly maculate upper surface, whereas *P. subrugatum* has an emaculate or weakly maculate upper surface. In addition, the apothecia of *P. nilgherrecens* are often perforate and the thalline exciple lacks laciniae and cilia. Typically, *P. subrugatum* has an ivory or mottled marginal zone on the lower surface, and a commonly pigmented lower medulla (skyrin), but the Chinese collections of this species have a brown marginal zone and lack skyrin.

Parmotrema subrugatum is known from Central and South America, southern Africa, Australia (Hale 1965; Elix 1994) and Papua New Guinea (Louwhoff & Elix 1999). In China this species has previously been reported from Yunnan (Hale 1965; Zhao 1964; Zhao *et al.* 1982) and Taiwan (Kurokawa & Lai 2001).

Representative specimens examined

CHINA. **Yunnan**, Gongshan County, *J.J. Su* 1514; Simao, *J.D. Zhao & Y.B. Chen* 3037, 3640, 3706; Xichou, *Q.Z. Wang* 25.

37. ***Parmotrema tinctorum*** (Despr. ex Nyl.) Hale, Phytologia **28**: 339 (1974)
≡ *Parmelia tinctorum* Despr. ex Nyl., Flora **55**: 547 (1872).

This species is characterized by the broad, eciliate lobes, the simple cylindrical to coralloid isidia and the presence of lecanoric acid in the medulla (K–, C+ red, KC+ red, P–). It closely resembles *P. pseudotinctorum*, but the latter species has markedly inflated isidia.

Parmotrema tinctorum is widely distributed throughout the tropical and temperate regions of the world (Elix 1994; Hale 1965; Krog & Swinscow 1981). In China this species has previously been reported form Beijing, Fujian, Guangxi, Guizhou, Henan, Shaanxi, Shandong, Shanghai, Xianggang, Xizang, Zhejiang and Taiwan (Wei 1991).

Representative specimens examined

CHINA. **Anhui**, Huangshan, *J.D. Zhao et al.* 5293. **Guangdong**, Dinghushan, *J.B. Chen et al.* 20842. **Guangxi**, Napo, *L.H. Chen* 980118, 980235. **Guizhou**, Ceheng County, *Q.Z. Wang* 603. **Hainan**, Diaoluoshan, *J.B. Chen et al.* 20494. **Hebei**, Wulingshan, *K.M. Liou* 3803. **Hubei**, Shennongjia, *J.B. Chen* 11007. **Hunan**, Sanzhi, *J.B. Chen et al.* 9899-1; Zhangjiajie, *J.B. Chen et al.* 8962, 9056. **Shandong**, Qufu, *Y.C. Zhu* 100, 123. **Shanghai**, Jinshan County, *Z.G. Qian* 8073. **Sichuan**, Dujiangyan, *J.C. Wei et al.* 97183. **Xizang**, Zhangmu, *J.C. Wei & J.B. Chen* 225, 619. **Yunnan**, Malipo. *J.B. Chen* 5439; Xishuangbanna, *J.B. Chen* 5474, 5562; Simao, *J.D. Zhao & Y.B. Chen* 2515, 3796; Xichou, *J.B. Chen* 5030. **Zhejiang**, Tianmushan, *J.D. Zhao & X.L. Wang* 6032.

Excluded Species

Parmotrema hababianum (Gyeln.) Hale, Phytologia **28**: 337 (1974)

This species is characterized by the ciliate lobes, a maculate upper surface, marginal soralia and the presence of norlobaridone, ±loxodin and protolichesterinic acid in the medulla (K–, C–, KC+ purple, P–). In China *P. hababianum* has been reported from Xizang by Wei & Jiang (1986), but these specimens has now been redetermined as *P. pseudonilgherrense* and contain alectoronic and α-collatolic acids rather than norlobaridone in the medulla.

Uncertain Species

1. ***Parmotrema conformatum*** (Vain.) Hale, Phytologia **28**: 335 (1974)

This species is characterized by the yellowish-green upper surface, ciliate lobes with dense isidia, imperforate discs and the presence of usnic acid in the cortex and malonprotocetraric, protocetraric and fumarprotocetraric acids in the medulla (K–, C–, P+ red). It has been previously reported from China by Zhao *et al.* (1982) based on three specimens from Yunnan. We have not been able to locate these specimens, but they are reported to lack cilia and have a P– medulla (Zhao *et al.* 1982). Consequently these specimens seem to have been misidentified and are unlikely to be *P. conformatum.*

2. ***Parmotrema latissimum*** (Fée) Hale, Phytologia **28**: 337 (1974)

This species has been reported previously from Shaanxi by Jatta (1902) and Zahlbruckner (1930) but we have not been able to trace the relevant specimens.

3. *Parmotrema perforatum* (Wulfen) Massal., Atti I. R. Istit. Veneto, ser. 3, **5**: 248 (1860)

This species is characterized by the ciliate lobes, a maculate upper surface, the absence of soredia and isidia and the presence of norstictic and connorstictic acids in the medulla (K+ yellow turning red, C–, KC–, P+ pale orange). In China *P. perforatum* has been reported from Yunnan by Jatta (1902), Zahlbruckner (1930), Zhao (1964) and Zhao *et al.* (1982). The specimens cited by Zhao and Zhao *et al.* have now been identified as *P. nilgherrense* and *P. subrugatum* respectively, and contain alectoronic acid rather than norstictic acid in the medulla. We have been unable to locate the specimens cited by Jatta and Zahlbruckner.

4. *Parmotrema sulphuratum* (Nees & Flot.) Hale, Phytologia **28**: 339 (1974)

This species has been reported previously form Yunnan by Hue (1889) and Zahlbruckner (1930) but we have not been able to trace the relevant specimens.

5. *Parmotrema zollingeri* (Hepp) Hale, Phytologia **28**: 339 (1974)

Specimens of *P. zollingeri* reported originally from Taiwan have now been redetermined as *P. overeemii* (Kurokawa & Lai 2001). Examination of the type material confirmed that *P. zollingeri* contains succinprotocetraric and fumarprotocetraric acids as major components, whereas *P. overeemii* contains protocetraric acid (Elix 1998). *Parmotrema zollingeri* was reported from mainland China by Zhao (1964) and Zhao *et al.* (1982) based on two specimens from Yunnan, but we have been unable to locate them.

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A reassessment of *Hemiphacidium*, *Rhabdocline*, and *Sarcotrochila* (*Hemiphacidiaceae*)

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Abstract—The presence or absence of an iodine reactive ascus tip has been applied inconsistently in *Hemiphacidiaceae*. The genera *Hemiphacidium* (I-) and *Sarcotrochila* (I+) have been differentiated based on the reaction despite a high degree of morphological and ecological similarity, while in the genus *Rhabdocline*, the iodine reaction has been used to differentiate species and circumscribe subspecies. Molecular phylogenetic analyses indicate that currently recognized subspecies of *R. weirii* are non-monophyletic while those of *R. pseudotsugae* form distinct sister lineages. The polyphyly of *R. weirii* suggests that the presence or absence of an I+ ascus pore is not a good predictor of species circumscriptions. To de-emphasize the importance of the iodine reaction in classification within *Hemiphacidiaceae* and to promulgate a classification more consistent with relationships revealed by molecular phylogenetics, we propose that *Hemiphacidium* be synonymized under *Sarcotrochila* and that subspecies of *Rhabdocline pseudotsugae* and *R. weirii* be raised to species rank. The following new combinations are proposed: *Sarcotrochila longispora*, *S. plana*, *S. convexa*, *Rhabdocline oblonga*, *R. obovata*, and *R. epiphylla*.

Key Words—discomycetes, iodine reaction, ITS, *Meria*, phylogeny

Introduction

Hemiphacidiaceae (*Helotiales*) was proposed by Korf (1962) for a group of inoperculate discomycetes that typically cause needle-blight or needle-cast diseases of conifers. All members of the family have small, erumpent apothecia that lack a covering layer and have a reduced ectal excipulum. Ascospores of most members of the family are initially hyaline and aseptate but become septate and melanized prior to germination. Korf included the following genera in *Hemiphacidiaceae*: *Sarcotrochila* Fuckel, *Hemiphacidium* Korf, *Rhabdocline* Sydow, *Fabrella* Kirschst., *Didymascella* Maire, *Naemacyclus* Fuckel, and *Gremmenia* Korf. *Naemacyclus* was subsequently transferred to *Rhytismataceae* (DiCosmo et al. 1983), and *Gremmenia* is considered a synonym of *Phacidium* Fr. (Reid and Pirozynski 1968). The genus *Korfia* Reid & Cain is also classified in *Hemiphacidiaceae.* Korf further divided the family into two tribes based on the presence (*Sarcotrochilae*) or absence (*Hemiphacidiae*) of an ascus pore that turns blue in iodine solution. Subsequent species circumscriptions in *Rhabdocline* (Parker and Reid 1969, Sherwood-Pike et al., 1986), and molecular phylogenetic analysis of nrDNA (Gernandt et al. 1997, 2001) have not supported the use of the ascus tip reaction at the level of subtribe in *Hemiphacidiaceae*.

Sarcotrochila and *Hemiphacidium* are both parasitic on needles of conifers. The genus *Sarcotrochila* was erected by Höhnel in 1917, *Hemiphacidium* by Korf in 1962. Both have ascospores that are initially hyaline and aseptate but become septate and melanized prior to germination, a character shared with other members of *Hemiphacidiaceae*. Four species currently are accepted in *Sarcotrochila*, three in *Hemiphacidium*. Korf (1962) recognized the similarity between *Hemiphacidium* and *Sarcotrochila*, but proposed the new genus to accommodate species having ascus apical pores that do not become blue in iodine, retaining species with a positive iodine reaction in *Sarcotrochila*. *Hemiphacidium* is not otherwise distinct from *Sarcotrochila*. Korf (1962) classified *Sarcotrochila* and *Hemiphacidium* in *Hemiphacidiaceae,* together with the genus *Rhabdocline* Sydow, which contains species having positive, as well as species with negative, ascus iodine reactions. On the basis of small subunit nrDNA sequence evidence, *Sarcotrochila macrospora* and *Hemiphacidium longisporum* are sister groups and probably congeneric (Gernandt et al. 2001).

Rhabdocline is a genus of parasitic inoperculate discomycetes of Douglas-fir (*Pseudotsuga* Carr.) foliage. The genus was erected by Sydow in 1922 as *R. pseudotsugae*, based on collections made by J. R. Weir from the Northwestern United States, but no holotype was designated. Parker and Reid (1969) recognized that several different unique forms were included in Weir's collections of *R. pseudotsugae*, including some specimens having iodine negative, and some having iodine positive ascus pore reactions, of which some also had an associated *Rhabdogloeum* anamorph.

Parker and Reid (1969) designated a lectotype and emended *R. pseudotsugae* to retain only the I- forms, creating *R. weirii* to accommodate forms with I+ ascus pores. Parker and Reid (1969) also recognized variants within both the I+ *R. weirii* and I- *R. pseudotsugae*, designating these variants as subspecies. Two subspecies in *R. pseudotsugae*, ssp. *pseudotsugae* and ssp. *epiphylla*, and three in *R. weirii*, ssp. *weirii*, ssp. *oblonga*, and ssp. *obovata*, were differentiated based on ascomatal characteristics and presence of a *Rhabdogloeum* anamorph, which is associated exclusively with *R. weirii* ssp. *weirii*. A second I+ species, *R. parkeri*, was described by Sherwood-Pike et al (1986), who elected species rank for this taxon, rather than following Parker and Reid's (1969) precedent by designating a fourth subspecies of *R. weirii*. The separation of *R. parkeri* was justified based on its endophytic habit and because its anamorph, *Meria parkeri*, was substantially different from *Rhabdogloeum*. A phylogenetic analysis of the genus based on the internal transcribed spacer (ITS) of nuclear ribosomal DNA showed *Rhabdocline* to be monophyletic with the anamorphic species *Meria laricis*, a needle cast pathogen of *Larix*, which is very similar to the *Meria* anamorph of *R. parkeri* (Gernandt et al 1997, Sherwood-Pike et al 1986).

The negative iodine reaction in *R. pseudotsugae* results from the absence of an apical pore in that species (Parker and Reid 1969, Kohn and Korf 1975). Phylogenetic analyses indicated that the absence of the iodine positive apical pore in *R. pseudotsugae* appeared to result from a single loss of this character in a derived lineage (Gernandt et al 1997). Furthermore, the phylogeny of *Rhabdocline* presented by Gernandt et al. (1997) based on ITS sequences did not support the separation of species based on ascus iodine reaction as proposed by Parker and Reid (1969). The I+ *R. weirii* ssp. *obovata* occurred together with the I- *R. pseudotsugae* in a well supported clade (Gernandt et al. 1997). *Rhabdocline weirii* ssp. *weirii* occurred on a separate branch basal to all other *Rhabdocline* species, including *M. laricis*.

The iodine reaction has thus been used inconsistently to differentiate taxa in *Hemiphacidiaceae*. It has been considered diagnostic at the genus level for *Sarcotrochila* and *Hemiphacidium* and at the species level within *Rhabdocline*. However, based on previous investigations (Gernandt et al. 1997, 2001), the iodine reaction does not appear to be a reliable character for differentiation of genera or species within the family. A phylogenetic analysis of the ITS region of *Hemiphacidiaceae* taxa was performed to test relationships between genera and species, with particular emphasis on classification based on the iodine reaction versus alternative approaches. This analysis differs from the one presented in Gernandt et al. (1997) in that it includes isolates of *R. weirii* ssp. *weirii* and an undescribed species of *Meria*, both isolated from *Pseudotsuga macrocarpa* (Vasey) Mayr. In addition to *Rhabdocline* taxa, the present study includes new sequences for *Hemiphacidium longisporum* Ziller & A. Funk, and *Sarcotrochila macrospora* Ziller & A. Funk. On the basis of this and previous analyses (Gernandt et al. 1997, 2001), and in view of the inconsistent application of the iodine reaction for differentiation of genera and species in *Hemiphacidiaceae*, we conclude that the iodine reaction has been overemphasized with respect to other morphological (and now molecular) characters and that *Hemiphacidium* should be considered a synonym of *Sarcotrochila*. In view of the differences in morphological characteristics and ecology, which are supported by molecular phylogenetic evidence, the subspecies of *Rhabdocline* described by Parker and Reid (1969) are here recognized as distinct species.

Materials and Methods

Rhabdocline weirii ssp. *weirii* DNA was obtained from a specimen of bigcone Douglas-fir (*P. macrocarpa*) foliage collected from Kersh Ranch, San Diego County, California, 17 May, 1968 by D. R. Miller and K. M. Swain (1969, Voucher #191, USDA Forest Service, Shasta Trinity National Forest, Redding, CA, USA). Isolates of an undescribed, endophytic *Meria*, here provisionally included under *M. parkeri*, were obtained from surface disinfected foliage of *P. macrocarpa*. Foliage was collected from trees growing in the Cleveland National Forest, 33.703° N, 116.739° W, SE corner of S26 T5S R2E, Riverside Co., San Jacinto Mts., ca. 2 km W of Mountain Center, CA along highway 74 on June 7, 2001. Healthy appearing needles were removed from branchlets, immersed in 95% ethanol for one min., transferred to a solution containing commercial laundry bleach (5.25% NaOCl) diluted 1:2 in water for 10 min., and then rinsed in 95% ethanol for one min. Surface disinfected needles were then aseptically cut into 1mm long segments, transferred to Petri dishes containing 2% malt agar, and incubated at room temperature. Fungi growing from the segments were isolated onto 2% malt agar slant tubes. Several sporulating isolates produced conidia and conidiophores resembling *M. parkeri* and were maintained for phylogenetic studies.

DNA for *R. weirii* and isolates of *Meria* from *P. macrocarpa*, *Hemiphacidium longisporum* (ATCC # 26761) and *Sarcotrochila macrospora* (ATCC # 26762) was extracted, PCR amplified, and sequenced as described in Gernandt et al. (1997). The resulting ITS region sequences (GenBank accession numbers AY645897–AY645900) were combined with previously published sequences for *Rhabdocline*, *Meria*, and *Fabrella tsugae* (Gernandt et al. 1997) in BioEdit 6.0.7 (Hall 1999) and aligned with ClustalW using the default settings (Thompson et al. 1994). The aligned data matrix is available in TreeBase. An unweighted parsimony branch-and-bound search was performed on the alignment using PAUP* vers. 4.0b10 (Swofford 2003). Branch support was estimated using 1000 bootstrap replicates with a branch-and-bound search. The hierarchical likelihood ratio as implemented in ModelTest (Posada and Crandall 1988) indicated that the HKY85 + gamma nucleotide substitution model was the most appropriate for the data. A maximum likelihood analysis was performed in PAUP* using the model and parameters indicated in ModelTest.

Results

The ITS region alignment included 18 sequences, was 510 b.p. in length, and included 128 variable sites, 97 of which were informative. Branch-and-bound analysis recovered three most parsimonious trees (length = 194 steps, consistency index = 0.82, consistency index excluding uninformative characters = 0.78, retention index = 0.89). The three most parsimonious trees (MPTs) varied in the position of the two *R. parkeri* isolates from coastal Douglas-fir, which were either monophyletic or paraphyletic (Fig. 1). These isolates did not form a clade with *R. parkeri* from interior Douglas-fir in any of the MPTs, but instead occupied a sister position to two *M. laricis* isolates, which in turn were the sister group to *R. obovata* (*R. weirii* ssp. *obovata* Parker and Reid), *R. pseudotsugae*, and *R. epiphylla* (*R. pseudotsugae* ssp. *epiphylla* Parker and Reid). *Rhabdocline weirii* as delineated by Parker and Reid (1969) was polyphyletic, with ssp. *obovata* in a derived part of the tree in a sister position to *R. pseudotsugae* while ssp. *weirii* occupied the basal lineage of the genus. With respect to other genera, *Hemiphacidium* and *Sarcotrochila* form a closely related sister group (differing at only three nucleotide positions, approximately 0.7%).

The maximum likelihood tree (not shown) was almost identical in topology to one of the parsimony trees, although differing from the tree shown in Fig. 1 in resolving the interior *R. parkeri* isolates and *M. parkeri* from bigcone Douglas-fir as the sister group to the four isolates of *R. weirii*.

Despite few MPTs, bootstrap values were low for several clades. Coastal *R. parkeri* isolates, which were not monophyletic in all MPTs received low support (52%), as did the sister relationship between *M. parkeri* from bigcone Douglas-fir and *R. parkeri* from interior Douglas-fir (57%). These latter species were sister to *R. weirii* in the

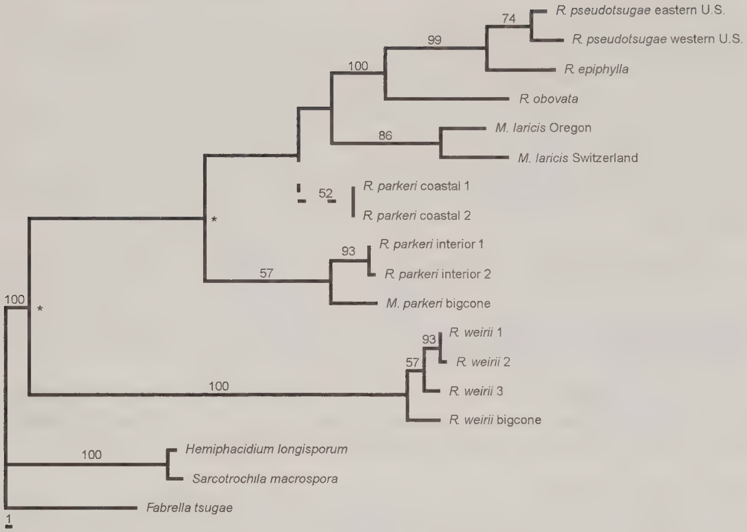
R. pseudotsugae eastern U.S.
R. pseudotsugae western U.S.
R. epiphylla
R. obovata
M. laricis Oregon
M. laricis Switzerland
R. parkeri coastal 1
R. parkeri coastal 2
R. parkeri interior 1
R. parkeri interior 2
M. parkeri bigcone
R. weirii 1
R. weirii 2
R. weirii 3
R. weirii bigcone
Hemiphacidium longisporum
Sarcotrochila macrospora
Fabrella tsugae
74
99
100
86
52
93
57
*
100
*
93
57
100
100
1

Fig. 1. One of three equally most parsimonious trees based on nuclear ribosomal ITS region DNA sequences from *Rhabdocline* and closely-related genera. Bootstrap values of 50% or greater are shown above the branches. The branch that collapses in the strict consensus tree is shown in dotted lines, and the branches marked by (*) are not recovered in the maximum likelihood tree. The scale bar indicates the number of steps.

maximum likelihood tree (see above). The relative position of interior *R. parkeri*, coastal *R. parkeri*, *M. laricis*, and the *R. pseudotsugae-R. epiphylla* clade received bootstrap below 50%. This result indicates that despite agreement in the three MPTs and the maximum likelihood tree, the placement of the root within *Rhabdocline* is not particularly robust.

Taxonomic part

Sarcotrochila Höhnel, Fragmente zur Mykologie 1010, Sitz.-ber. K. Akad. Wiss. Wien, Math.-nat. K1. I 126:309. 1917; emended J.K. Stone & D.S. Gernandt. Family *Hemiphacidiaceae*, order Helotiales. Holotype: *S. alpina* (Fuckel) Höhnel.

=*Hemiphacidium* Korf, Mycologia 54:21. 1962. Holotype: *H. planum* (Davis) Korf.

=*Stegopezizella* Sydow in Sydow & Petrak, Ann. Myc. 22:392. 1924. Holotype: *S. balsamae* (Davis) Sydow.

Apothecia foliicolous on conifers, minute, light colored, erumpent; opening by a disk-like flap of host epidermis. Excipulum of reddish-brown or hyaline parallel hyphae. Covering layer absent. Asci clavate, uniseriate or biseriate with pores blued or not blued in iodine. Ascospores initially hyaline, non-septate, but becoming brown and septate. Paraphyses cylindrical to filiform, septate, sometimes slightly swollen at the apex.

Accepted species:

Sarcotrochila alpina (Fuckel) Höhnel, Fragmente zur Mykologie 1010, Sitz.-ber. K. Akad. Wiss. Wien, Math.-Nat. K1. I. 126:309. 1917.

Sarcotrochila balsameae (Davis) Korf, Mycologia 54: 29. 1962. Isotype: Herb. BPI 669656, Vilas Co., WI, USA, Jul 27, 1902 by J. J. Davis. Specimens examined: Herb. BPI: 669631, Eldee Lake, Ont. Canada, Sept 15 1981; 669632, White River, Ont. Canada, Aug 14, 1962; 669633, Laurentide Park, QC, Canada, Sept 12 1962; 669636, Carrigan Notch, NH, USA, Aug 31, 1938.

Sarcotrochila convexa (Dearn.) J.K. Stone & D.S. Gernandt, comb. nov. Basionym: *Phacidium convexum* Dearness, Mycologia 18:238. 1926. No specimens examined. Korf (1962) notes the lectotype and paratype specimens are not in good condition and refers to the description of this species in Dearness (1926).

Sarcotrochila longispora (Ziller & A. Funk) J.K. Stone & D.S. Gernandt, comb. nov. Basionym: *Hemiphacidium longisporum* Ziller & A. Funk, Can. J. Bot. 51:1960. 1973. Holotype: DAVFP 20382, Tofino, B.C. Canada, Sep 9, 1972 by W. G. Ziller.

Sarcotrochila macrospora Ziller & A. Funk, Can. J. Bot. 51:1960. 1973. Holotype: DAVFP 20243, Tofino, B.C. Canada, Jun 21, 1972, by W. G. Ziller. Specimens examined: Herb BPI: 746983, Tofino, BC, Canada, June 21, 1972.

Sarcotrochila piniperda (Rehm) Korf, Mycologia 54:30. 1962. Specimens examined: Herb. BPI: 669637, White River, Ont. Canada, Aug 9, 1960; 669638, Mountjoy, Ont., Canada Aug 20, 1962.

Sarcotrochila plana (Davis) J.K. Stone & D.S. Gernandt, comb. nov.; Basionym: *Phacidium planum* Davis, Trans. Wisc. Acad. Sci. Arts Lett. 20:424. 1922. Isotype: Herb. BPI 669511, Mosinee WI, USA, Jul 7, 1919, by J. J. Davis. Specimens examined: Herb. BPI: 669639, Manhattan CO, USA, Jul 27, 1963; 669640A, Woodland Park, CO, USA, Aug 28, 1963; 669640B, Woodland Park, CO, USA, Aug 28, 1963.

Key to species of *Sarcotrochila*

1. On *Pinus contorta*, ascospores 40–100 x 2–3μm **2**
1. On other hosts, ascospores smaller **3**
    2. Ascospores large, filiform 50–100 x 2–3 μm .... ***S. macrospora***
    2. Ascospores clavate 45–70 x 2–3 μm .... ***S. longispora***
3. Ascus tips blued in iodine solution, ascospores 9–22 x 3–8 μm **4**
3. Ascus tips not blued in iodine solution **5**
    4. On *Larix*, ascospores fusiform, 10–12 x 3–4 μm .... ***S. alpina***
    4. On *Picea*, ascospores ellipsoidal, 9–14 x 3–6 μm .... ***S. piniperda***
    4. On *Abies*, ascospores 10–22 x 6–8 μm .... ***S. balsameae***
5. On *Pinus rigida*, ascospores ovoid .... ***S. convexa***
5. On *Pinus* spp. ascospores clavate, 25–40 x 4–6 μm .... ***S. plana***

New combinations in *Rhabdocline*:

Rhabdocline epiphylla (Parker & Reid) J.K. Stone & D.S. Gernandt comb. nov. Basionym *Rhabdocline pseudotsugae* spp. *epiphylla* Parker & Reid (1969) Can. J. Bot. 47:1533–1545. Holotype: DAVFP 18700, collected at Malahat, B.C., Canada, June 8, 1966 by A. K. Parker. Specimens examined: BPI 670606, collected at Malahat, BC, Canada, June 8, 1966 by A. K. Parker; BPI 670608, collected at Klamath, CA, USA, May 19, 1969 by D. R. Miller.

Rhabdocline obovata (Parker & Reid) J.K. Stone & D.S. Gernandt comb. nov. Basionym *Rhabdocline weirii* ssp. *obovata* Parker & Reid (1969) Can. J. Bot. 47:1533–1545. Holotype: DAVFP 17867 Collected at Malahat, B.C. Canada, June 8, 1966 by A. K. Parker. Specimens examined: BPI 670614, collected at Star, OR, June 22, 1921 by J. S. Boyce; BPI 670703, collected at Potter Valley CA, USA, May 17, 1930 by E. P. Meinecke.

Rhabdocline oblonga (Parker & Reid) J.K. Stone & D.S. Gernandt comb. nov. Basionym *Rhabdocline weirii* ssp. *oblonga* Parker & Reid (1969) Can. J. Bot. 47:1533–1545. Holotype: DAOM 90045, collected at Hamilton MA, USA, May 21, 1933 by G. D. Darker. Specimens examined: (BPI 670708 collected at Providence RI, May 27, 1929 by E. P. Meinecke, and 670720, collected at Hamilton MA, USA, May 21 1933 by G. D. Darker).

Key to species of *Rhabdocline*

1. Apothecia on abscised needles of Douglas-fir in needle litter; fall, winter,
    minute, < 0.5mm diam . . . . ***R. parkeri***
1. Apothecia on diseased, attached or recently abscised needles; spring, summer 2
    2. *Rhabdogloeum* anamorph present . . . . ***R. weirii***
    2. *Rhabdogloeum* anamorph absent 3
3. Apothecia mainly epiphyllous, paraphyses clavate, to 10μm broad . . ***R. epiphylla***
3. Apothecia mainly hypophyllous 4
    4. Ascus tips not blued in iodine solution . . . . ***R. pseudotsugae***
    4. Ascus tips blued in iodine solution 5
5. Apothecia on either side of the needle midrib, most less than 4mm long,
    ascospores obovate, some two-celled, the larger cell turning brown while
    still in the ascus . . . . ***R. obovata***
5. Apothecia irregularly rectangular, occupying full width of needle . . . ***R. oblonga***

Discussion

The species *Hemiphacidium longisporum* and *Sarcotrochila macrospora* were described simultaneously by Ziller and Funk (1973). Both were associated with other needle parasites on *Pinus contorta* Dougl. *Hemiphacidium longisporum* was consistently found in association with *Lophodermella concolor* (Dearn.) Darker, *S. macrospora* was consistently associated with *Davisomycella ampla* (Davis) Darker. Ziller and Funk (1973) remarked about the similar morphology and ecology of these two species, and stated that they appeared to represent varieties of the same species. However, following Korf's (1962) classification of the *Hemiphacidiaceae,* Ziller and Funk placed the two species in different genera. Molecular phylogenetic studies based on nuclear ribosomal small subunit (SSU) sequences of a large sampling of ascomycetes (Gernandt et al. 2001) showed these to be very closely related sister species in a well supported clade that includes *Rhabdocline* spp. and *Fabrella tsugae* (Farl.) Kirschst., i.e. *Hemiphacidiaceae*. A close relationship is also supported by the ITS analysis in the present study, in which sequences of *H. longisporum* and *S. macrospora* differed at only three nucleotide positions. While we do not advocate the sole use of specific sequence divergence thresholds for determining taxonomic rank, this small degree of divergence in nrITS adds support for considering *H. longisporum* and *S. macrospora* congeneric. Unfortunately other species of *Hemiphacidium* and *Sarcotrochila*, including the type species, are not readily available for sequencing. Nevertheless, we feel justified in synonymizing *Hemiphacidium* under *Sarcotrochila* despite such limited sampling because of the apparent unreliability of the iodine reaction as diagnostic of genus level differences and to de-emphasize its importance in the classification of *Hemiphacidiaceae*.

Molecular sequence data are too incomplete to demonstrate whether or not *Hemiphacidiaceae* sensu Korf (1962) is monophyletic. Other ITS region sequences available in GenBank show low levels of divergence with *Rhabdocline*, including *Piceomphale bulgarioides*, *Leptodontium*, *Neofabraea* species, and several genera of *Sclerotiniaceae*. Because of difficulty in aligning ITS region sequences among *Hemiphacidiaceae* sensu Korf and suitable outgroup taxa, we were unable to confirm that *Hemiphacidiaceae* is monophyletic to the exclusion of these other taxa. In the case of *Piceomphale*, small subunit sequences suggest that it occurs in a sister position to *Hemiphacidiaceae* (Gernandt et al. 2001). We suggest that a more conservative marker and broader taxonomic sampling is needed to test adequately the monophyly of *Hemiphacidiaceae*.

Kohn and Korf (1975) reviewed the several different iodine reactions of taxonomic significance in fungi, including the bluing of the ascus apical pore. In particular they stressed that pretreatment with KOH could render specimens of *Chloroscypha*, *Dermea*, and *Pezicula* iodine positive although they react negatively without pretreatment. Baral (1987) investigated the iodine reactions of a number of lichenized and nonlichenized ascomycetes and observed that in several species different color reactions occurred depending on the concentration and composition of the iodine reagents. In particular, Baral (1987) observed that hymenial elements of several species show a red reaction in IKI solution but are negative in Melzer's reagent (which contains chloral hydrate in addition to I_2 and KI). Baral proposed the term "hemiamyloid" for such species. If pretreated in KOH, these species produce a blue reaction with either reagent, i.e. the same phenomenon as reported by Kohn and Korf (1975). The iodine reactions of several species also were observed to grade from red to blue with decreasing I_2 concentration. Therefore care must be taken in evaluating the iodine reactivity of any given species. None of the fresh or herbarium specimens of species of *Rhabdocline* or *Sarcotrochila* examined by us exhibited a hemiamyloid reaction.

Furthermore, some other genera of discomycetes and pyrenomycetes have species with either I+ or I- reactions, regardless of pretreatment. Parker and Reid (1969) used the iodine reaction to differentiate two species of *Rhabdocline*, *R. weirii* having I+ asci and *R. pseudotsugae* having I- asci. A second I+ species, *R. parkeri*, was described by Sherwood-Pike et al (1987). The negative iodine reaction in *R. pseudotsugae* results from the absence of an apical pore in that species (Parker and Reid 1969, Kohn and Korf 1975). An ITS region phylogeny of *Rhabdocline* indicated that iodine negative asci appear to result from a single loss in the most derived species, *R. pseudotsugae* (Gernandt et al. 1997). This finding supports Nannfeldt's (1976) hypothesis that in genera that vary in iodine reaction, I- species are derived from I+ species, presumably from reduction of the apical apparatus during speciation. A similar situation occurs in *Anthostomella* Sacc. Some species, such as *A. formosa* Kirschst. lack an apical ring and are iodine negative (Francis 1975).

The classification proposed by Parker and Reid (1969), based primarily on ascus iodine reactions, does not reflect evolutionary relationships, as previously noted (Gernandt et al. 1997). Promotion of the subspecies of *Rhabdocline* to species rank is a simple solution to this problem. These taxa vary in a number of morphological and ecological characters (Table I). Furthermore, the amount of sequence divergence between the proposed species ranged from about 3.9–6.1% between *R. parkeri* and *M. laricis*, to 11.2–11.6% between *R. weirii* and *R. obovata*, indicating a sufficient level of divergence to justify recognition of separate species. The elevation of *R. epiphylla* to species rank is not as well-supported by ITS sequences as is the case for *R. obovata* because the former taxon does form a monophyletic group with *R. pseudotsugae*. Nevertheless, *R. epiphylla* and *R. pseudotsugae* are clearly distinguished by ITS region sequences (0.8–1.1% divergence), and more importantly, by the epiphyllous habit, and larger, swollen paraphyses of *R. epiphylla.*

One of the subspecies named by Parker and Reid (1969), *Rhabdocline weirii* ssp. *oblonga*, was not included in the sequencing and analysis because fresh material was not available. This taxon is known from only a few collections, cited in Parker and Reid (1969), who expressed some hesitation at erecting the subspecies but did so on the grounds that it appeared distinct from *R. weirii* ssp. *weirii* in lacking the *Rhabdogloeum* anamorph. We elect to designate this taxon as a species here, despite its somewhat uncertain status, to maintain consistency in *Rhabdocline* taxonomy. Although this species is similar to *R. weirii*, we feel that the absence of the *Rhabdogloeum* state that is consistently present in *R. weirii* collections warrants recognition as a distinct species.

The importance of the iodine reaction in ascomycete taxonomy has been questioned. Sherwood (1981) noted that the morphology of ascus apices is often anomalous, and an unreliable indicator of evolutionary relationships, in fungi that fruit on aerial plant surfaces. She reasoned that the relative ease of ascospore discharge in this environment placed fewer constraints on dehiscence mechanisms but greater evolutionary pressure on spore morphology. Bellemère (1994) considered ascus characters of secondary importance in ascomycete systematics. Nannfeldt (1976) argued that the iodine reaction may be a more reliable taxonomic character for some groups of ascomycetes than for others; it should not necessarily be diagnostic at the same taxonomic level across orders and families and so each case should be evaluated separately. The wisdom of this reasoning is obvious, since ascus tip morphology and dehiscence

Table I. Synopsis of morphological and ecological characters for *Rhabdocline* taxa, including the anamorph genus *Meria*.

	R. epiphylla	***R. parkeri***	***R. pseudotsugae***	***R. weirii***	***R. obovata***	***R. oblonga***	***M. laricis***
Ascus	I-	I+	I-	I+	I+	I+	NA
Anamorph	none	*Meria*	none	*Rhabdogloeum*	none	none	*Meria*
Host	*Pseudotsuga*	*Pseudotsuga*	*Pseudotsuga*	*Pseudotsuga*	*Pseudotsuga*	*Pseudotsuga*	*Larix*
Culture[1]	No	Yes	No	No	?	?	Yes
Fruiting	spring	fall/winter	spring	spring	spring	spring	spring/summer
Ascoma habit	epiphyllous	hypophyllous	hypophyllous or epiphyllous	hypophyllous	hypophyllous	hypophyllous	hypophyllous
Ecology	pathogen	endophyte	pathogen	pathogen	pathogen	pathogen	pathogen
Ascoma shape	circular or rectangular	circular	rectangular	rectangular	circular or rectangular	circular or rectangular	n/a
Ascoma size	0.5mm	0.05–0.5 mm	0.3–0.6 x 0.5–10 mm	0.3–0.4 x 5-10 mm	0.3–0.6 x 0.5-4 mm	0.3-0.6 x 0.5-4 mm	n/a
Ascoma position	either side of midrib	either side of midrib	either side of midrib	either side of midrib	either side of midrib	full width of needle	n/a
Paraphyses	clavate	clavate	filiform-clavate	filiform-clavate	filiform	filiform	n/a
Paraphyses max width	10 μm	7 μm	3.5 μm	3.5 μm	2.5 μm	2.5μm	n/a
Ascospores	14–21 x 6–9 μm	10-13 x 4-5.5 μm	13–19 x 5–7 μm	13–19 x 4–8 μm	16–22 x 6–9 μm	14–22 x 5–9 μm	n/a
Sheath	present	absent	present	present	present	present	n/a
Polar appendages	absent	present	absent	absent	absent	absent	n/a

[1] *R. pseudotsugae* and *R. epiphylla* have been reported to germinate and grow on specialized media (Parker and Reid 1969), but do not grow readily on routine media such as malt agar.

mechanisms are highly variable throughout the ascomycetes and different ascus iodine reactions may stem from non homologous characters (Bellemère 1994). Other genera of discomycetes, such as *Lachnelulla, Schizothyrioma, and Pyrenopeziza* also have species that vary in ascus iodine reactions, and such variation is prevalent in the *Dermateaceae* (Nannfeldt 1976). In *Hemiphacidiaceae,* the ascus iodine reaction has been inconsistently applied as diagnostic of species level differences in *Rhabdocline* versus genus level in *Sarcotrochila* and *Hemiphacidium.* The nomenclatural changes introduced in this paper are intended to apply the iodine reaction more uniformly in classification of *Hemiphacidiaceae* and to draw attention to other traditional characters that could receive relatively greater emphasis in the future.

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Jack D. Rogers, Martha A. Sherwood and R. P. Korf provided helpful comments on the manuscript. Laura D. Merrill provided collections of *P. macrocarpa* foliage. Greg DeNitto and John Pronos provided *Rhabdocline* specimens.

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Dactylella coccinella sp. nov., an anamorphic species

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Abstract—*Dactylella coccinella*, isolated from the teleomorphic fungus *Orbilia coccinella*, is described as a new anamorphic species. Diagnostic characters that distinguish this anamorphic fungus from other *Dactylella* species are a simple conidiophore that bears a single, cylindrical, 1-7-septate conidium with a round distal end, a monoblastic conidiogenous cell, cylindrical and absence of nematode trapping capability.

Key words—anamorph species, ITS sequence

Introduction

The anamorphic genus *Dactylella* Grove is a heterogeneous group that has not yet been systematically studied. In our taxonomic research of *Dactylella*, an isolate derived from *Orbilia coccinella* (Sommerf.) Fr. by Benedict in October 1972, was studied for details. Comparison of its morphological and biological characters and analysis of sequence data of the rDNA in ITS region suggest that the fungus is a separate species. Therefore, we describe it as a new anamorphic species, *Dactylella coccinella*.

Materials and methods

FUNGAL STRAINS—The fungal strain *Dactylella coccinella* CBS 916.72, originally isolated by Benedict in October 1972 from *Orbilia coccinella* (Sommerf.) Fr., was kindly provided by Dr. Walter Gams from Centraalbureau voor Schimmelcultures. *Dactylella clavata* Gao, Sun & Liu (CBS 167.95) was originally isolated by our lab and preserved in CBS. The cultures were maintained according to their specific requirements.

GROWTH, MORPHOLOGY AND PREDACITY—Fungi were cultured on Potato Dextrose Agar (PDA) and Cornmeal Agar (CMA) in the dark at 23°C. Morphological characteristics and the growth rate were measured after incubation of two weeks. Trapping organs were induced by inoculation of challenging nematodes *Panagrellus redivivus* into a 10 ×10 mm square slot at the margins of the colony where the agar was removed, and observed directly under a compound microscope after 1-3 days (Gao et al. 1996). Observation, measurement and photograph were carried out in water or cotton blue lacto-phenol mounts under Olympus B51 microscope with differential interference contrast (DIC). All microscopic characteristics were measured from more than 50 individuals in water mounts.

DNA EXTRACTION, PCR AMPLIFICATION AND SEQUENCING—Fresh mycelium was collected from the cultures growing on cellophane membrane on the PDA surface in Petri dish plates. Genomic DNA was extracted from the mycelium according to the method described by Doyle & Doyle (1987). The ITS region including the intervening 5.8S rDNA, were amplified with the standard primers of ITS1 and ITS4 (White et al. 1990). The reactions were carried out in a thermal cycles with following parameters: initial denaturation at 95˚C for 3 min, followed by 34 cycles consisting of denaturation at 94˚C for 1 min, annealing at 54˚C for 40 s and extension at 72˚C for 1 min. A final extension at 72˚C for 10 min followed. Primary PCR products were purified by Go3S PCR Product Purification Kit (Shenergy Biocolor BioScience & Technology Company, Shanghai, China) and sequenced on both directions with an ABI automated Sequencer (ABI 377) (Perkin Elmer) using ye-dideoxynucleotide chain-termination method. The edited sequences were deposited in GenBank (Table 1).

PHYLOGENETIC ANALYSIS—The determined ITS sequences were submitted to molecular phylogenetic analysis. Additional sequences (Table 1) were obtained from GenBank using direct queries for the genera involved, and using *Gliocladium roseum* Bainier as an outgroup (Hagedorn & Scholler 1999). An alignment of the rDNA sequences was generated by the program package Clustal-X 1.81 (Thompson et al. 1994; 1997), and then it was manually realigned using BioEdit version 5.0.6 (Tom Hall, Department of Microbiology, North Carolina State University, Raleigh, NC 27695). Phylogenetic analysis was performed using PAUP* 4.0 beta 10 (Swofford 2001) with gaps treated as missing data and all characters having equal weight.

Taxonomy

Dactylella coccinella sp. nov. FIGURE 1

Etym.: the species is named after its teleomorphic species name.

> *Coloniae in agaro PDA effusae, post 14 dies 23°C 28 mm diam., pallide brunneae, hyphis aeriis sparsis. Hyphae superficiales ramosae, intertextae, frequenter anastomosantes, septatae, ad septa non constrictae, 2-3 μm latae, leves, hyalinae vel subhyalinae. Conidiophora hyalina, recta, simplicia, solitaria, septata, laevia, 35-187.5 μm longa, basi 2-3 μm crassa, ad apicem angustata 1.7-2.5 μm crassa. Conidia singularia, cylindrica, ad extremum distale rotundata vel obtusa, 1-7-septata, plerumque triseptata usque quinqueseptata, laevia, hyalina, 22.5-32.5 μm longa, 5-6.5 μm lata. Teleomorphus Orbilia coccinella (Sommerf.) Fr.*

Colonies when grown on PDA at 23°C for 14 days reach 28 mm in diameter, effuse, slightly brown, felty with sparse aerial mycelium and brown on the reverse. *Mycelium* compose of hyaline, septate, branched hyphae; hypae 2-3 μm wide. *Conidiophores* erect, unbranched, hyaline, septate, 35-187.5 μm long, 2-3 μm wide at the base, and tapering to 1.7-2.5 μm at the apex, bearing with only one holoblastic conidium. Conidiogenous cells monoblastic, integrated, terminal, cylindrical, hyaline, smooth.

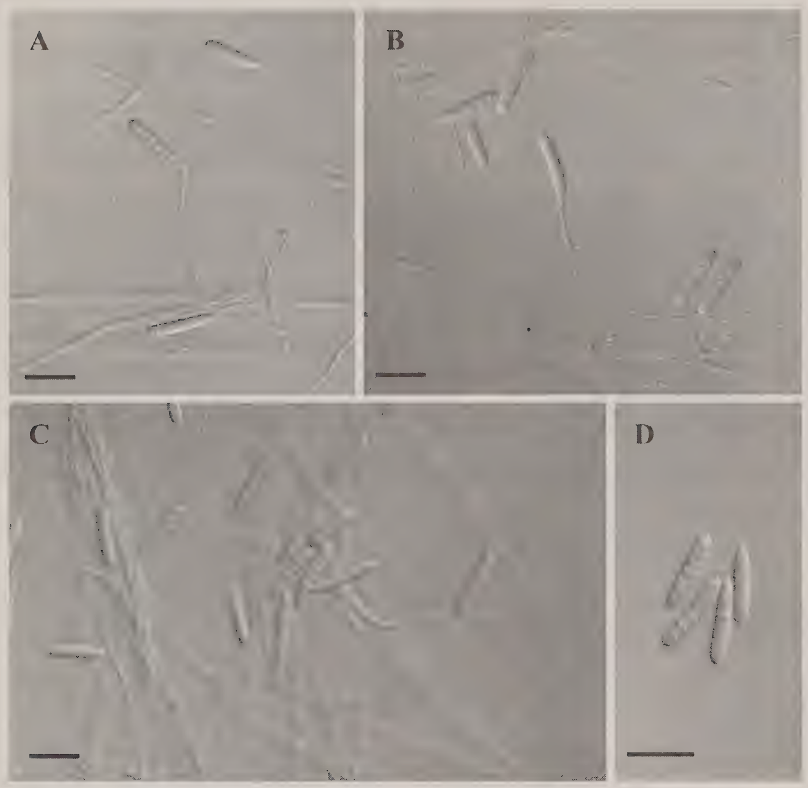

Fig. 1. *Dactylella coccinella* (Holotype HMAS 87787). A-B. Conidiophores with attached conidia. C. Conidia. D. Magnification of conidia showing septa. Scale bar = 10 μm.

Conidia cylindrical, straight or slightly curved, smooth, round to blunt at distal end, 1-7- transverse septate (mainly 3-5), 22.5-32.5 × 5-6.5 μm. No chlamydospore has observed. No traps and capture ability has been detected in pure culture when induced by *P. redivivus*.

Holotype: Specimen on microscope slide was deposited in Herbarium Mycologicum, Institute Microbiologici, Academiae Sinicae, HMAS 87787. Living culture CBS 916.72.

Discussion

Dactylella Grove was first established in 1884. In the original description, the type species of the genus *D. minuta* Grove was incapable to prey nematodes (Rubner 1996). But this genus has been emended to include both non-predacious and predacious fungi based on their similar morphological characters (Subrammanian 1963, Schenck et al. 1977, de Hoog & Oorschot 1985, Zhang et al. 1994). Rubner (1996) revised the generic characteristics of *Dactylella* and noted that, when the predacious capability was considered in partition of the genus, *Dactylella* must be restricted to non-predacious species. Scholler et al. (1999) accepted this amendment, and only placed non-predacious species in *Dactylella* according to their rDNA sequence analysis. So we assign this non-predacious fungus in *Dactyella.*

D. coccinella is characterized by cylindrical, 1-7-septate conidia with round distal ends, simple conidiophore bearing only one conidium at apex, and no predacity. In conidia shape and number of septa, this fungus resembles *Dactylella cylindrospora* (Cooke) Rubner, *Dactylella clavata* Gao, Sun & Liu, *Dactylellina asthenopaga* (Drechsler) Scholler, Hagedorn & Rubner, *Dactylella tenius* Drechsler and *Dactylella heptameres* Drechsler, but can be distinguished from them via the following characteristics: *D. cylindrospora* has polyblastic conidiogenous cells and 1-4-septate conidium; *D. clavata* has branched conidiophores and clavate conidia with 1-7-septa; *Da. asthenopaga* produces obconical to clavate conidia with 3-septa and stalked knobs to trap nematode; *D. tenius* has clavate conidia with 1-4-septa; *D. heptameres* has polyblastic conidiogenous cells with geniculate proliferation bearing 5-10 conidia.

By amplifying the ITS region, *D. coccinella* generated a 553 bp amplicon, and *D. clavata* a 534 bp amplicon. A Blast similarity search (Altschul et al. 1990) of *D. coccinella* on the consensus sequence of the ITS region demonstrated a close relationship with the genus *Orbilia*. A cladogram based on phylogenetic analysis of the ITS regions (Fig. 2) shows that *D. coccinella* is clustered together with all non nematode-trapping *Dactylella* and

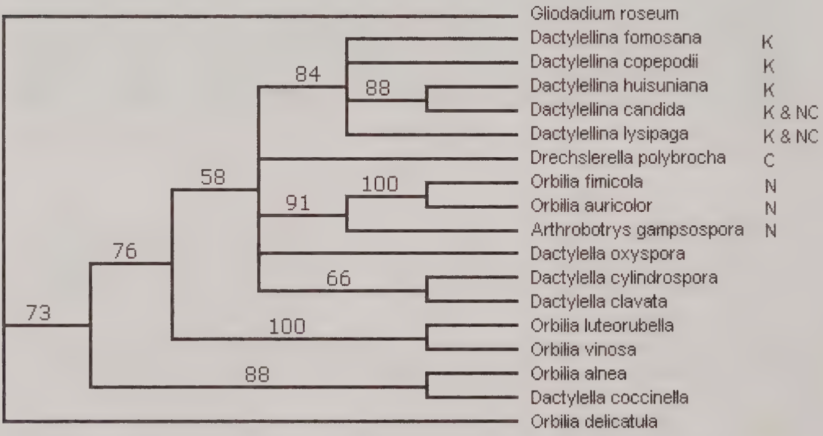
Gliocladium roseum
Dactylellina fomosana K
Dactylellina copepodii K
Dactylellina huisuniana K
Dactylellina candida K & NC
Dactylellina lysipaga K & NC
Drechslerella polybrocha C
Orbilia fimicola N
Orbilia auricolor N
Arthrobotrys gampsospora N
Dactylella oxyspora
Dactylella cylindrospora
Dactylella clavata
Orbilia luteorubella
Orbilia vinosa
Orbilia alnea
Dactylella coccinella
Orbilia delicatula
84
88
58
100
91
76
66
73
100
88

Fig. 2. Most parsimonious analysis with related species inferred from ITS DNA sequence data in PAUP* 4.0 beta 10. The number associated with each branch represents the percentage of 1000 bootstrap supporting that branch, with only bootstrap values >50% shown. Consistency index (CI) = 0.5500, and Retention index (RI) = 0.5503. NCBI accession numbers are explained in table 1. **K** = adhesive knob; **NC** = non-constricting ring; **C** = constricting ring; **N** = adhesive network.

Orbilia species, while all nematode-trapping species form its own group which agrees with Scholler et al. (1999). This result also supports the inclusion of this new fungus in the genus *Dactylella*. Further more *D. coccinella* is clustered with *Orbilia alnea* (whose anamorph was *Dactylella* sp. without capture activity (Pfister 1997)) in a monophyletic clade with three bases different in 5.8s rDNA regions, this indicates that the two species are phylogentically closely related and distant with other *Dactylella* species.

Table 1. Species used in phylogenetic analysis

Anamorph (following Scholler et al. 1999)	**Teleomorph**	**Predacious devices**	**GenBank Acc. #**
Dactylellina formosana	Unknown	Knob	U51956
Dactylellina copepodii	Unknown	Knob	U51964
Dactylellina huisuniana	Unknown	Knob	U51965
Dactylellina candida	Unknown	Knob & non-constricting ring	U51963
Dactylellina lysipaga	Unknown	Knob & non-constricting ring	U51959
Drechslerella polybrocha	Unknown	Constricting ring	U51973
Arthrobotrys superba	*Orbilia fimicola*	Networks	U72599
Arthrobotrys cladodes var. *macroides*	*Orbilia auricolor*	Networks	U72592
Arthrobotrys gampsospora	Unknown	Networks	U51960
Dactylella oxyspora	Unknown	None	AF106537
Dactylella cylindrospora	Unknown	None	AF106538
Dactylella clavata (CBS 167.95)	Unknown	None	AY515568
Non-sporulating (DHP 146)	*Orbilia luteorubella*	None	U72607
Non-sporulating (CBS 917.72)	*Orbilia vinosa*	None	U51981
Dactylella sp.	*Orbilia alnea*	None	U72601
Dactylella coccinella (CBS 916.72)	*Orbilia coccinella*	None	AY515567
Dicranidion sp.	*Orbilia delicatula*	None	U72595
Gliocladium roseum	*Bionectria ochroleuca*	None	AF106532

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L'hamathécium de *Stigmidium squamariae*, ascomycète lichénicole non lichénisé Conséquences systématiques

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Résumé—L'hamathécium de *Stigmidium squamariae* est constitué de périphyses et de pseudoparaphyses courtes du type b, ce qui rend nécessaire la suppression du groupe de *S. squamariae* et le placement de l'espèce dans le groupe de *Stigmidium placynthii*. *S. squamariae* est observé pour la première fois sur un *Rhizoplaca (R. peltata)*.

Abstract—The hamathecium of *Stigmidium squamariae* consists of periphyses and short pseudoparaphyses of type *b*. As a consequence, the *S. squamariae*-group has to be suspended, and *S. squamariae* is included in the *Stigmidium placynthii*-group. *Rhizoplaca* is reported as a new host genus for *S. squamariae* (host species: *R. peltata*).

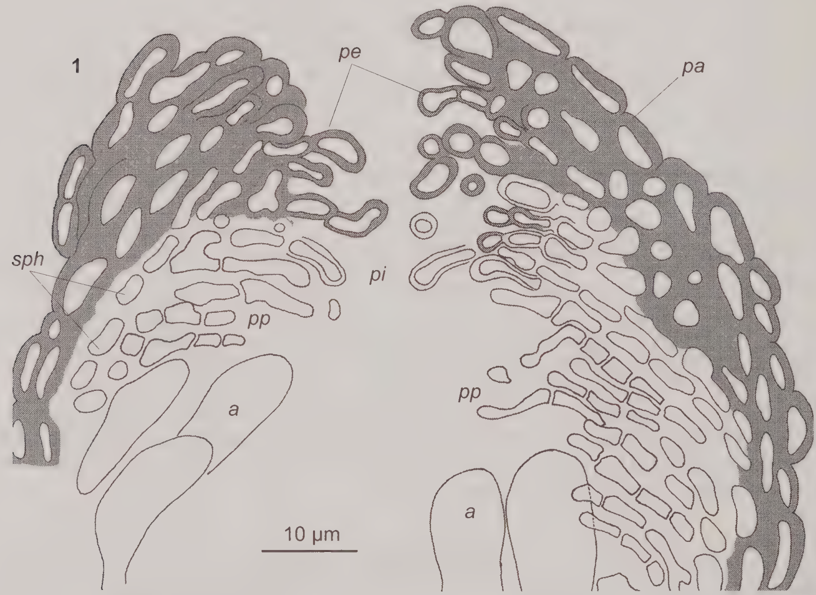
Resumo—La hamatecio de *Stigmidium squamariae* konsistas el perifizoj kaj pseŭdoparafizoj mallongaj de la tipo *b*, kio necesigas la forigon de la grupo de *S. squamariae* kaj la lokadon de la specio en la grupon de *Stigmidium placynthii*. Unuafoja observo de *S. squamariae* en *Rhizoplaca* (*R. peltata)*.

Introduction

Roux et Triebel (1994) ont décrit en détail *Stigmidium squamariae* (de Lesd.) Cl. Roux et Triebel, champignon lichénicole parasymbiote dans les apothécies de *Lecanora* gr. *muralis* [*L. muralis* (Schreb.) Rabenh., *L. bipruinosa* Fink, *L. novomexicana* H. Magn. et *L. phaedrophthalma* Poelt], de *L. polytropa* et (Hafellner et al. 2003) de *L. pseudomellea* B. D. Ryan. Toutefois, contrairement à toutes les autres espèces de *Stigmidium* étudiées par Roux et Triebel (1994), des pseudoparaphyses courtes n'ont pas été observées dans l'hamathécium, si bien que ces auteurs ont placé ce champignon dans un groupe monospécifique, le groupe de *S. squamariae,* d'origine incertaine par rapport aux deux autres groupes de *Stigmidium* distingués essentiellement par le type de leurs pseudoparaphyses courtes, les *Stigmidum* s.s. et les *Stigmidum* du groupe de *S. placynthii*. L'étude de nouveaux spécimens—dont deux sur *Rhizoplaca peltata* (Ramond) Leuckert et Poelt, hôte nouveau—, à ascomes bien développés, nous a permis d'observer l'hamathécium de *S. squamariae* dans de bonnes conditions et de le décrire ci-après.

Méthodes

Les coupes et préparations microscopiques ont été réalisées à main levée et observées dans l'eau et le bleu coton au lactophénol, avec un microscope photonique (grandissement maximal de ×1500) muni d'un dispositif de contraste interférentiel. Les dessins ont été réalisés avec l'aide d'un tube à dessin. Les spécimens disponibles étant anciens, les mesures ont été effectuées dans l'eau, sur du matériel mort. Dans l'expression des



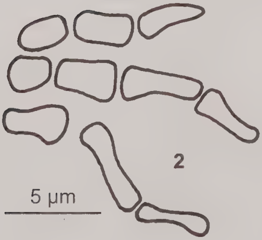


Fig. 1. Structure microscopique de la moitié supérieure d'un ascome de *Stigmidium squamariae* (Th. Nash III n° 6526) d'après une coupe verticale passant par l'ostiole, observée dans le bleu au lactophénol. *a*: asque; *pa*: paroi ascomale; pe: périphyses de la formation externe; *pi*: périphyses de la formation interne; *sph*: suprahyménium.
Pour la partie inférieure de l'ascome et les appendices hyphoïdes, voir Roux et Triebel (1994: 459).

Fig. 2. Pseudoparaphyses courtes isolées de *Stigmidium squamariae* (Berger n° 8747) observées dans le bleu au lactophénol.

dimensions des spores (halo non compris) la moyenne est indiquée en italique, encadrée par les valeurs extrêmes après élimination des 10 % des valeurs les plus élevées et des 10 % des valeurs les plus faibles, tandis que les valeurs extrêmes absolues sont placées entre parenthèses.

Résultats

La fig. 1 montre que l'hamathécium de *S. squamariae* est constitué de deux types d'éléments, de l'extérieur vers l'intérieur:

- Des **périphyses**, rudimentaires et peu visibles, de (3)5-10 × (1)2-3 μm, localisées dans le court canal ostiolaire, dont on peut distinguer deux types (Janex-Favre, 1971; Roux et Triebel, 1994): les périphyses de la formation externe (*pe* sur la fig. 1), situées tout à fait dans la partie supérieure du canal ostiolaire, issues de la paroi ascomale, pigmentées, et les périphyses de la formation interne (*pi*), situées immédiatement au-dessous des précédentes, issues de la partie tout à fait basale du canal ostiolaire, incolores ou presque.
- Des **pseudoparaphyses courtes** (*pp*)—encore nommées périphysoïdes (voir Calatayud et Triebel 2003, tab. 1), terme à éviter car prêtant à confusion: voir Roux et Triebel 1994: 462—, peu visibles, réduites, de 10-15 × 2-3,5 μm, et d'aspect analogue aux périphyses de la formation interne, mais s'en distinguant par leur localisation (au-dessous du canal ostiolaire), leur origine (issues du suprahyménium) et la forme des cellules qui les constituent. Les pseudoparaphyses courtes de *S. squamariae* (fig. 2) étant constituées de trois ou quatre cellules toutes nettement plus larges que celles des périphyses et leur cellule basale n'étant pas ou peu distincte des autres cellules, elles appartiennent donc au type *b* défini par Roux et Triebel (1994).

Par ailleurs, l'examen de spécimens plus nombreux, à ascomes mieux développés, sur des hôtes plus variés, nous permet de donner des valeurs plus représentatives des dimensions des asques et des spores de *S. squamariae*: asques: 22-44 × 11-19μm—d'après 18 mesures; spores: (8,5)9,5-*10,9*-12,5(14) × (4)5-*5,3*-5,5(6) μm, à rapport longueur sur largeur de (1,8)2,0-*2,2*-2,4(2,6) μm—d'après 126 mesures.

Discussion

Le groupe de *S. squamariae*, réduit à cette seule espèce et caractérisé par l'absence de pseudoparaphyses (Roux et Triebel 1994), doit être abandonné. L'hamathécium est donc homogène dans l'ensemble du genre *Stigmidium* (duquel il faut exclure le groupe de «*Stigmidium*» *psorae*, Calatayud et Triebel, 2003) et constitué de périphyses et de pseudoparaphyses courtes généralement peu visibles. *S. squamariae* doit être placé dans le groupe de *S. placynthii* qui regroupe les espèces à paraphyses du type *b*. Outre *S. squamariae*, trois espèces appartiennent avec certitude à ce groupe, *S. conspurcans* Triebel et R. Sant., *S. placynthii* Roux et Nav.-Ros. (Triebel et Roux, 1994) et *S. clauzadei* Cl. Roux et Nav.-Ros. (Roux et Navarro-Rosinés, 1994), puisque *S. catapyrenii* Cl. Roux et Triebel (Triebel et Roux 1994) doit être mis en synonymie avec *Epibryon conductrix* (Norman) Nik. Hoffmann et Hafellner (Hoffmann et Hafellner 2000). Dans le groupe de *S. placynthii*, *S. squamariae* se singularise par des ascomes munis d'appendices hyphoïdes (Roux et Triebel 1994), caractéristique qu'il partage avec les *Stigmidium* s.s. (à pseudoparaphyses courtes du type *a*), mais la paroi des ascomes de *S. conspurcans* est couverte de papilles qui peuvent être considérés comme des appendices hyphoïdes réduits.

Les appendices hyphoïdes ne sont donc pas toujours associés aux pseudoparaphyses courtes de type *a*. Les deux groupes de *Stigmidium* distingués ne diffèrent donc que par le type de pseudoparaphyses courtes, si bien qu'il semble préférable de ne pas démembrer les *Stigmidium* en deux genres sur la base de ce seul caractère, d'autant plus que de nombreuses espèces de *Stigmidium* n'ont pas encore fait l'objet d'une révision moderne.

Enfin, nous mentionnons *S. squamariae* pour la première fois sur un *Rhizoplaca, R. peltata*, puisqu'il n'avait été jusqu'ici noté que sur des *Lecanora* gr. *muralis*, sur *L. polytropa* et sur *L. pseudomellea* (voir Introduction). Étant donnée la spécificité parasitaire des *Stigmidum* (Roux et Triebel 1994), on peut en déduire que tous ces lichens présentent une parenté incontestable et s'interroger sur la valeur du genre *Rhizoplaca* dont Arup et Grube (2000), au moyen d'analyses moléculaires, ont mis en évidence l'hétérogénéité et remis en question sinon la validité du moins la compréhension.

Spécimens examinés

- USA, Arizona, Coconino, Echocliffs, 16 km SSW of Page, along U.S. 89. On sandstone. Sur apothécies de *Lecanora phaedrophthalma*. Alt. 5400'. Leg. Th. Nash III n° 6526, 1973/04/23 (ASU).
- Canaries, La Palma, Caldera de Taburiente, Gipfel Pico de la Nieve. Sur apothécies de *Rhizoplaca peltata*. Alt. 2350 m. Leg. F. Berger n° 8747, 1995/05/09 (herb. Berger).
- Iran, Téhéran, in declivibus praeruptis ad pedem montium Elburz supra Evine-Teheran. Ad saxa silicea. Sur apothécies de *Rhizoplaca peltata*. Alt. ca. 2300m. Leg. J. Soják, 1973/03/14. Vèzda, Lich. sel. Exs. n°1217, *Omphalodina peltata* (M).

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Roux C, Navarro–Rosinés P, 1994. *Stigmidium clauzadei* sp. nov., nelikeniĝinta fungo likenloĝa (Ascomycetes). *Bull. Soc. linn. Provence* 45, Hommage scientifique à G. Clauzade : 443-450.

Roux C, Triebel D, 1994. Révision des espèces de *Stigmidium* et de *Sphaerellothecium* (champignons lichénicoles non lichénisés, Ascomycetes) correspondant à *Pharcidia epicymatia* sensu Keissler ou à *Stigmidium schaereri* auct. *Bull. Soc. linn. Provence* 45, Hommage scientifique à G. Clauzade: 451-542.

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New data on rare species of *Hydnochaete* and *Hymenochaete (Hymenochaetales)*

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Abstract—New data on distribution and additional data on structure and variation of basidiomata are given for *Hydnochaete peroxydata* and twenty seven species of the genus *Hymenochaete*: *H. acanthophysata, H. adusta, H. amboinensis* nom. nud., *H. berkeleyana, H. berteroi, H. coffeana, H. colliculosa, H. depallens, H. gigaspora, H. globispora, H. innexa, H. livens, H. magnahypha, H. microspora, H. mollis, H. murina, H. muroiana, H. ochromarginata, H. pectinata, H. pellicula, H. plurimisetae, H. raunkiaeri, H. separabilis, H. sphaerospora, H. tuberculosa, H. unicolor* and *H. vallata*. Four species, *H. berkeleyana, H. fomitiporoides, H. fuscobadia* and *H. lignosa* are placed in synonymy. The new combinations *Hymenochaete pectinata* and *Coniophora deflectens* are proposed. Lectotypes are designated for *H. pectinata* and *H. raunkiaeri*.

Key words—Hymenomycetes, spore variation

Introduction

Though several good papers by D.J. Job and L. Ryvarden, and an excellent monograph by J.-C. Léger (1998) have been published during last twenty years, many species of the genera *Hydnochaete* and *Hymenochaete* remain insufficiently known and data on their distribution are scarce. I have been able to visit the herbaria ARIZ, BPI, DD, K, L, LSUM, NY, O, PAN, S, study specimens received on loan from several other herbaria, and examine collections sent to me by many friends and colleagues. The resulting new data on very rare or poorly known species are presented in this paper.

Most of the specimens of these fungi are sterile in herbaria, i.e., without any basidia and spores. Microscopic data on spore size published in older papers have sometimes been obtained using low magnification and do not sufficiently demonstrate the infraspecific variation of this important character. Therefore, data on spore statistics of the specimens studied were added to the descriptions.

Methods

Basidiomata are described using the colour names of Rayner (1970); colour notations are given according to the Munsell Book of Color (1976; abbreviation: M) and Kornerup & Wanscher (1967; abbreviation: K & W). Microscopic study was undertaken by making free-hand sections or squash mounts in 2% aqueous solution of KOH. For spore statistics, 25 randomly selected spores were measured in each specimen with the aid of a Sony CCD Video Camera attached to a Nikon Labophot 2 microscope and analysed by Global Lab Image (Data Translation Inc.) software. Figures have been made using the images captured by the same software. Species descriptions given below are based on new collections and types only; for some species, full descriptions are not provided but only new, additional morphological and other data. Herbarium acronyms follow Holmgren, Holmgren & Barnett (1990); biogeographical regions are named as in the Plant Taxonomic Database Standard No 2 (Brummitt 2001).

Taxonomic Descriptions

Hydnochaete peroxydata (Berk. & M.A. Curtis) Dennis, Kew Bull. Addit. Ser. 3: 105 (1970); Ryvarden, Mycotaxon 15: 435 (1982). – *Hydnochaete badia* Bres., Hedwigia 35: 287 (1896). – *H. brasiliensis* Rick (a herbarium name in BPI).

Fig. 34

Basidiome effused, closely adnate, coriaceous when dry, up to 8 cm in diam, 200–2000 μm thick; hymenophore usually odontioid, raduloid or distinctly hydnoid, but in some cases slightly poroid or colliculose and similar to the hymenium of *Hymenochaete* species. Hymenium ashy-pinkish when young, then reddish brown to dark brown or blackish (M: 7.5 YR 4/5; K & W: 7 E 4 to 7 F 5, fawn to brown). No spores seen in the specimens studied.

Known distribution. South America: Brazil, Venezuela.

Types studied. *Hydnum peroxydatum* Berk. & M.A. Curtis: Northern South America: Venezuela, no. 134 (K, lectotype). *Hydnochaete badia:* Brazil, St. Catharina, Blumenau, 1894 Moller 211 (S, lectotype selected by L. Ryvarden); Möller 268 (S, paratype).

New localities. Central America: Costa Rica, Parque La Amistad Sn Vito, Coto Brunx Punatrenas, J. Carranga 257–97 (O). South America: Brazil, Rio Grande do Sul, Lajeado, 1921 J. Rick (BPI 266602); Sao Leopoldo, 1929 Rick (BPI 266554, 266555); Rio Grande do Sul, Sao Leopoldo, 1932 J. Rick (BPI 266559); Sao Leopoldo, Fungi Austro-Americani 32, 1904 Rick (S; BPI 266557, 266558); Sao Leopoldo, Theissen, Decades fungorum brasilianum 162 (BPI 348611); Brazil, J. Rick (BPI 348612); Brasil, coll. & det. J. Rick as *Hydnochaete brasiliensis* (BPI 266603); Rio Grande, Hamburgerberg, 21 Oct 1892 Malme 79 (S); Rio de Janeiro, 1914 Torrend (S); Bahia, C. Torrend, det. C.G. Lloyd as *Hymenochaete simulans* (BPI 329978, Lloyd Herb. 3264); Sao Paulo, Parque do Estado, 25 Apr 1971 B.V. Skvortzov (LSUM).

Hymenochaete acanthophysata J.C. Léger, Mycotaxon 13: 249 (1981); Léger, Hymenochaete 42, f. 3 (1998).

Figs. 12, 40

Basidiome effused, 0.5–2 cm in diam, later confluent and up to 10 cm or more long; hymenium smooth or with some few deep cracks, greyish brown or fulvous umber (M: 5 YR 4/2 or 7.5 YR 4/6; K & W: 6 E 5–7, cocoa brown), in sterile specimens brown due to the crowded dendrohyphidia in the hymenial layer (M: 7.5 YR 4/6–7, K & W: 6 E 8, rust brown), in old specimens sometimes brownish grey (M: 5 YR 6/2; K & W: 6 D 4, camel colour); margin distinct, concolorous with the hymenium.

Setae few, 30–60 x 6–10(–12) μm. "Acanthohyphidia" (Léger's term) are in many cases true dendrohyphidia, very numerous, 25–30 μm high, 3–4 μm diam. Spores (4–)4.2–5.0(–5.2) x 1.5–2.2 μm.

Known distribution and hosts. WEST TROPICAL AFRICA: Ivory Coast (one locality); WEST-CENTRAL TROPICAL AFRICA: Gabon; on *Klainedoxa gabonensis, Ancystrophyllum* sp. and on unknown hosts.

New localities. WEST TROPICAL AFRICA: Sierre Leone, Mano (Duse), on a dead trunk of *Copaifera copallifera,* 13 Sep 1949 IMI 38376 (K); Njala (Kori), on severed leaf rachis of oil palm *[= Elaeis guineensis],* 19 Aug 1949, M2969A (K); same locality, on dead branch of *Cassia sieberiana,* 24 Aug 1949 (K). WEST-CENTRAL TROPICAL AFRICA: Cameroon, S.W. Province, Mundemba, Korup Forest Reserve, 29 Jan 1989 and 7 Apr 1990 R. Watling 21354, 22127 (E 60205, 60208); Ghana ('Gold Coast Colony'): Abe, on wood, 15 May 1949 S.J. Hughes 632, 633 (K); Abari, on *Cynometia tricitensis,* 3 May 1949 S.J. Hughes 185 (K); Bunan, on *Hevea brasiliensis,* 17 Jun 1949 S.J. Hughes 566 (K); Bunsu, on *Hevea brasiliensis,* 12 May 1949 S.J. Hughes 1305 (K), on *Theobroma cacao,* 17 Jun 1949 S.J. Hughes 1306 (K); 3–4 miles W of Nsuaem on Takoradi-Tarkwa Rd., on wood and bark, 8 May 1949 S.J. Hughes 216 (K); Tarkwa, on *Hevea brasiliensis,* 12 May 1949 S.J. Hughes 566 (K).

Comments. The very closely related South and East Asian species *H. murina* differs in absence of hyphal layer, shorter denticles of acanthohyphidia and slightly bigger spores (4.2–)4.8–6.0(–6.5) x (1.8–)1.9–2.4 μm.

Mean spore size and mean *Q* value of *H. acanthophysata:*

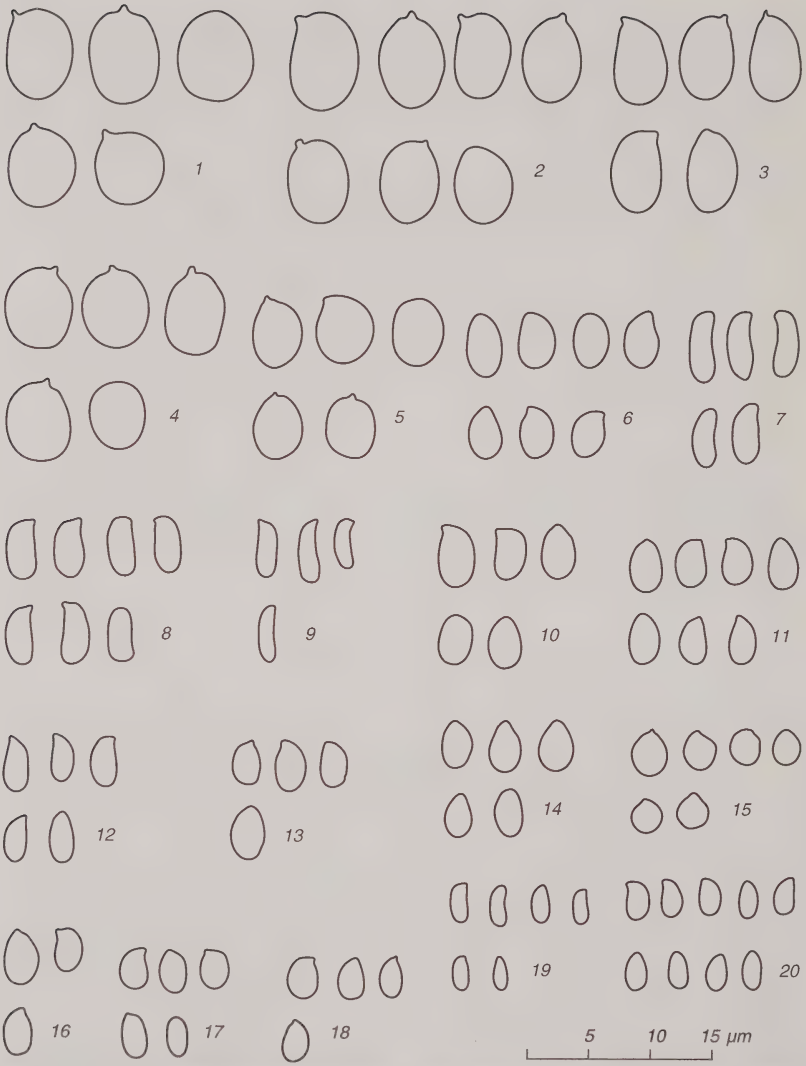
4.52 x 1.75 μm	2.58	Cameroon, K, Hughes 1306
4.66 x 1.87 μm	2.49	Ghana, K 39084/a
4.84 x 1.96 μm	2.47	Cameroon, E 60205

HYMENOCHAETE ADUSTA (Lév.) Har. & Pat., J. Bot. (Morot) 17: 7 (1903); Aoshima & Furukawa, Trans. Mycol. Soc. Japan 7 (1): 12, f. 1–2 (1966); Léger, Hymenochaete 45, f. 4–5 (1998); Hjortstam, Roberts & Spooner, Kew Bull. 53 (4): 808 (1998). – *H cacao* (Berk.) Berk., J. Linn. Soc., Bot. 10 (46): 333 (1868); Parmasto, Mycotaxon 79: 137 (2001). Figs. 15, 38

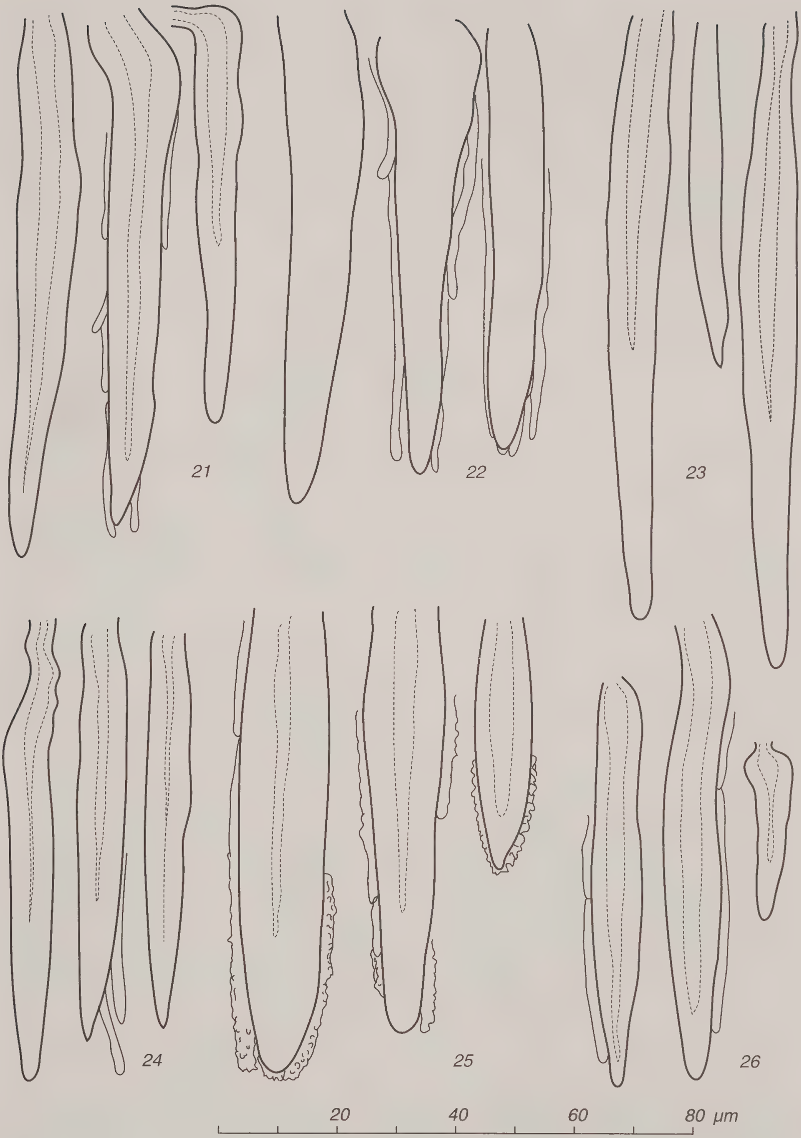
Basidiomata sessile-pileate, imbricate, forming rosettes, 300–800 μm thick; pileal surface concentrically sulcate and zonate, radiately fibrillose, silky, brown to dark brown (M: 10 R 3–4/2–4; K & W: 6–7 E–F 7–8).

Tomentum thin or indistinct, with gradual transition to the hyphal layer; cortex absent but in the hyphal layer there are locally regions of densely com-pacted hyphae observable in sections under a lens as short dark lines; hyphal layer 100–700 μm thick.

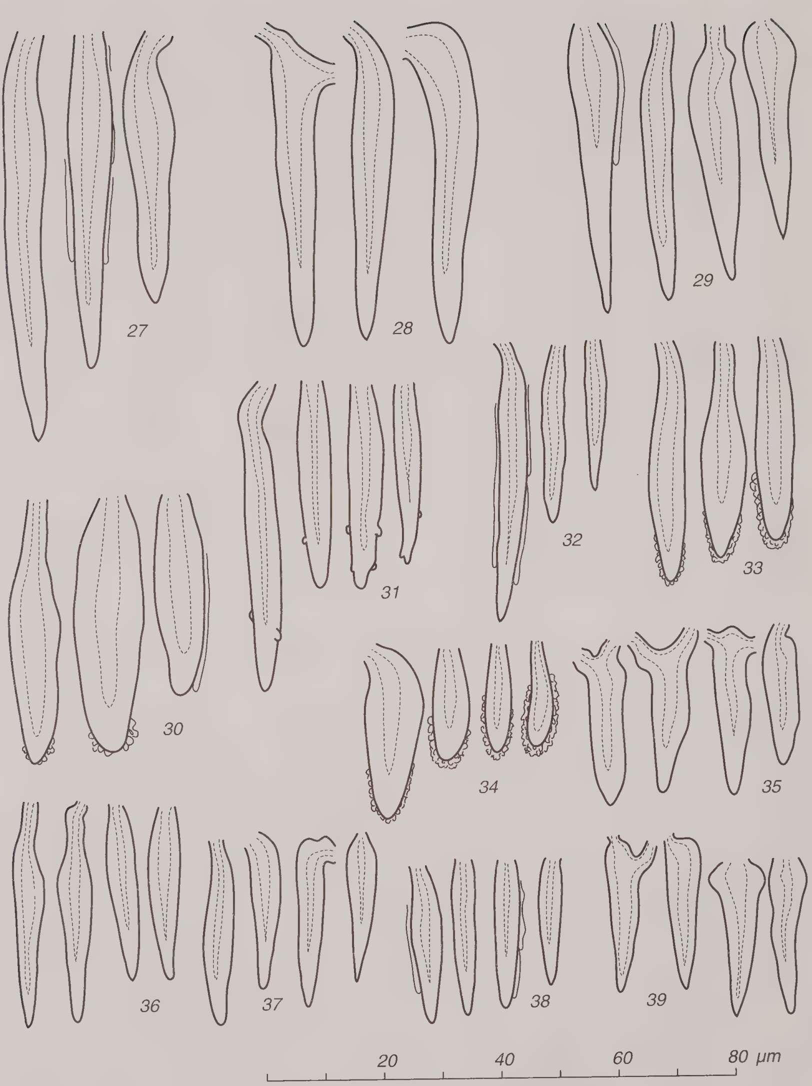
Hyphal system subdimitic; hyphae in hyphal layer radially arranged (in parallel), with thickened walls and rare septa, brownish, 3–5 μm in diam, hyphal ends of the tomentum partly somewhat irregularly clavate and then encrusted with granules of amorphous matter. Setae numerous or scattered, subulate-subfusoid, 25–35 x (4.5–)5–7 μm, straight, with acute tip, naked (without hyphal sheath). Basidioles numerous, yellowish, with slightly thickened and lowly uneven walls, 25–30 x 4–5 μm; basidia subcylindrical, 25–30(–35) x 5–6 μm, with 4 thin sterigmata 2.5–3.5 μm long; spores broadly ellipsoid or almost subsphaerical or lacrymoid, some with a guttula, 2.7–3.2(–3.3) x 2.1–2.5 μm.



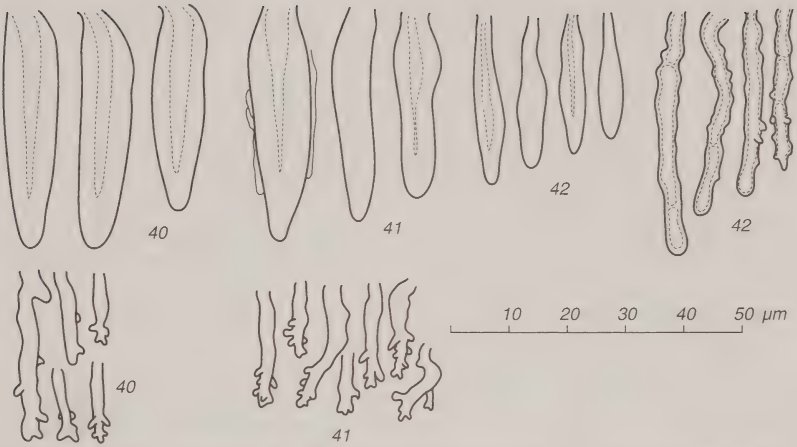
Figs. 1–20. Spores: 1 – *Hymenochaete gigaspora* (BPI 299845), 2 – *H. colliculosa* (TAA 65685), 3 – *H. depallens* (K, Rattan 5571), 4 – *H. sphaerospora* (Léger 633), 5 – *H. globispora* (BR 1398), 6 – *H. unicolor* (O 10354), 7 – *H. murina* (TAA 103432), 8 – *H. innexa* (TAA 103220), 9 – *H. plurimisetae* (PDD 16559), 10 – *H. separabilis* (BPI 278122), 11 – *H. microspora* (O 42274), 12 – *H. acanthophysata* (E 60205), 13 – *H. berteroi* (BPI 329824), 14 – *H. tuberculosa* (NY 27422c), 15 – *H. adusta* (TAA 159579), 16 – *H. muroiana* (TAA 159658), 17 – *H. ochromarginata* (Krug 66.2260), 18 – *H. coffeana* (TRTC 52675), 19 – *H. vallata* (K, Roberts B12), 20 – *H. raunkiaeri* (SP 1404).


21
22
23
24
25
26
20
40
60
80 µm

Figs. 21–26. Setae: 21 – *Hymenochaete gigaspora* (BPI 299845), 22 – *H. innexa* (Hawaii, AZ 18411), 23 – *H. depallens* (K, Ahmad 14849), 24 – *H. colliculosa* (TAA 65685), 25 – *H. sphaerospora* (Léger 633), 26 – *H. berteroi* (NY 184).



Figs. 27–39. Setae: 27 – *Hymenochaete globispora* (SP 92226), 28 – *H. microspora* (BAFC 30323), 29 – *H. unicolor* (O 10354), 30 – *H. magnahypha* (NY, Teng 3308), 31 – *H. separabilis* (BPI 278122), 32 – *H. ochromarginata* (H, Niemelä 5122), 33 – *H. plurimisetae* (PDD 16559), 34 – *Hydnochaete peroxydata* (O, Carranga 257-87), 35 – *Hymenochaete muroiana* (TAA 159658), 36 – *H. raunkiaeri* (LSUM 2352), 37 – *H. vallata* (K, Roberts B12), 38 – *H. adusta* (TAA 159579), 39 – *H. coffeana* (TRTC 52675).



Figs. 40–42. Setae and hyphidia: 40 – *H. acanthophysata* (O 17565), 41 – *H. murina* (BPI 329818), 42 – *H. tuberculosa* (NY 27422c)

Known distribution and hosts. Eastern Asia, Indo-China, Malesia, Australasia, possibly also North America (North Carolina), Central and South America; everywhere rare. Found on *Distylium racemosum, Lithocarpus* sp. and on several unknown hosts.

Types studied. *Stereum adustum* Lév.: Malesia, Philippines, Manila (S, iso-lectotype). *Stereum cacao* Berk.: Indian Subcontinent: India, Khasia, 7 Jul 1850 Hooker (K, holotype; LSUM, BPI 277664, 277665, 277667 and Lloyd Herb. 29713, isotypes).

New localities. Indian Subcontinent: India, West Bengal, Distr. Darjeeling, Pashok forest, alt. 2500 ft, 7 Jul 1974 S.K. Gupta 279 (BPI 1100810). Indo-China: Thailand, Khao Yai Nat. Park, close to headquarters, on a fallen trunk of an angiospermic tree, 3 Aug 1997 U. Kõljalg (TAA 159579). Malesia: Malaysia, Southern Malaya, Perak, on *Balanocarpus heimii,* F.W. Foxworthy (BPI 277505); Sabah ('British North Borneo'), Elphinstone Prov., Tawao, Oct 1922–Mar 1923 A.D.E. Elmer 20243, 20617 (BPI 277466, 277467).

Comments. Spores of *H. adusta* have been described as 3–3.5 x 1.5–1.8 μm by Léger (1998:46) who has seen these in one specimen, collected from Thailand; my measurements fit better with the size of spores given by Aoshima & Furukawa (1966: 13: 2.5–3.5 x 2–2.5 μm) and Hjortstam, Roberts & Spooner (1998: c. 3 x 2.5 μm, few seen). Size of setae is (18–)20–25(–30) x 4–5 μm according to Léger (1998), 30–40 x 5–7.5 μm after Aoshima & Furukawa (1966), and I found it to be 20–30(–40) x 5–7(–8) in the Philippine specimens in herbarium S.

Types of both *H. adusta* and *H. cacao* are old specimens without spores, as also are all collections identified as *H. cacao* from Venezuela, Central America, Caribbean and USA studied by me (BPI). The differences between *H. adusta* and *H. cacao* indicated by Léger (1998): less dark colour of pileal surface, lack of incrustation of hyphal ends in tomentum and very numerous setae in *H. cacao* are characters variable in the species of *Hymenochaete*. The two taxa are conspecific in Asia, but a question remains: is the

American *H. cacao* the same? Fresh specimens with spores must be collected in that region for a further study.

Mean spore size and mean *Q* value of *H. adusta:*

2.97 x 2.29 μm	1.29	Thailand, TAA 159579

HYMENOCHAETE AMBOINENSIS Henn., *nomen ineditum;* Henn. ex Bres. & H. Sydow, Philipp. J. Sci. C. Botany 9 (4): 351 (1914), *nomen nudum;* Léger, Hymenochaete 53, f. 8 (1998), *nomen seminudum.*

According to Léger (1998: 35, 53), the species is similar to *H. fomitiporoides* (and *H. murina*), but differs by its slightly larger setae (30–50 x 6–8 μm) protruding less above the hymenium (up to 15 μm vs. up to 30 μm in *H. fomitiporoides*).

"Type" studied. *H. amboinensis* Henn.: WEST-CENTRAL TROPICAL AFRICA, Burundi, Amboin, Usumbura, C. Hohz (Holiz?) (S, isotype?).

Comments. The "type" of Henning's species is without basidia or spores, but with numerous brownish simple, unbranched hyphidia with thickened walls and rounded tips. Its identity is unknown; anyway, it is very different from *H. amboinensis* sensu Léger

The specimen only mentioned from Philippines but not described by Bresadola and Sydow in 1914 ("Luzon, Province of Rizal, *Bur. Sci. 13464 Ramos,* February, 1911") is absent among Bresadola's specimens in S. Another specimen in S (Philippinae, Merrill, 13462) labelled "Hymenochaete amboinensis P. Henn. (ined.) forma" has been used by Léger (1998) in his description of this species. It also is sterile, but has setae 25–45(–50) x 8–12 μm and numerous acanthohyphidia; it is indistinguishable from *H. murina.*

H. amboinensis is a name to be deleted from the list of *Hymenochaete* species.

HYMENOCHAETE BERKELEYANA (Mont.) Cooke, Grevillea 8: 147 (1880); Léger, Hymenochaete 64, f. 13 (1998). – *Stereum berkeleyanum* Mont., Ann. Sci. Nat. Bot. IV 1: 140 (1854) = **H. RHEICOLOR** (Mont.) Lév.

Types studied. NORTHERN SOUTH AMERICA: Guyana, Leprieur (S, isotype); "Authentic" (BPI 329849 and 32850, Lloyd Herb. 29726 and 29724, possibly isotypes).

Comments. The isotype specimens studied by me are all sterile but have setae and hyphae typical of *H. rheicolor.* The differences between these two taxa indicated by Burt (1918: 313) and Léger (1998: 27, 66) are minute and within the limits of the variation of the basidiomata of *H. rheicolor.*

HYMENOCHAETE BERTEROI Pat., Bull. Soc. Mycol. France 10: 78 (1894); Léger & Lanquetin, Bull. Soc. Mycol. France 103 (1): 20, f. 1 (1897); Job, Mycol. Helvet. 4 (1): 8 (1990); Léger, Hymenochaete 66, f. 14 (1998). Figs. 13, 26

Basidiome effused, adnate but margins sometimes loose, soft coriaceous, 150–500 μm thick; hymenium smooth, with some deep cracks, umber (M: 5 YR 4/4; K & W: 6 E 6, cocoa brown).

Tomentum absent; context composed of hymenium, a thick layer of loosely interwined adscending hyphae with infrequent hyphal setae, and with a layer of densely parallel hyphae near the substrate; in some places between the two layers and the substrate a thin cortex is present.

Hyphal system monomitic; generative hyphae septate, in subhymenial layer frequently branched, with inequally thickened walls (monilioid), reddish brown, 3–5 μm in diam, in the layer of parallel hyphae with thickened walls, brownish, 2.5–4 μm in diam. Setal hyphae (embedded setae) downwards curved, 100–150 x 6–8 μm; hymenial setae numerous, subulate, (45–)50–80 x 7–10(–12) μm, acute, sheathed, emerging 30–50 μm above the hymenium. Basidioles numerous, subhyaline, (20–)25–35(–40) x 3.5–5(–6) μm, encrusted with granules; basidia cylindrical, 30–50 x 4–5.5 μm; sterigmata 4, 3.5–4 μm long; spores ellipsoid, one side slightly flattened, 3.5–4.8 x 2.0–2.7 μm.

Known distribution and hosts. Southern South America: Chile, Juan Fernández Is.; Western Indian Ocean: Réunion, on *Psidium cattleyanum*.

New localities. East Tropical Africa: Kenya, Chogoria track E. Mt. Kenya, *Macaranga kilimandscharica* log, Jan 1973 no. 184 (NY). Australia: Kangaroo Is., 1926 J.B. Cleland 937 (BPI 329824, Lloyd Herb. 2856). Northwestern Pacific: Hawaii, Oahu, Pupukea Forest Reserve, on *Acacia koa*, 31 Jan C.L. Shear 113 (BPI 1100595). Northern South America: Venezuela, Parque Nacional Henri Pittier, Rancho Grande Res. Station, 21 Feb 2000 L. Ryvarden 42299 (O, TAA).

Comments. *H. berteroi* is very closely related to *H. semistupposa* Petch; the latter species differs in its lack of setal hyphae and narrower elongated-ellipsoid spores 3.2–4.2 x 1.7–2.2 μm.

The upper stratum of hyphal layer up to 100 μm thick has been described by Léger (1998: 67) as cortex, but its hyphae are not agglutinated (cemented); moreover, there is a thin (up to 20 μm) true cortex composed of brown densely interwoven hyphae present in some parts of the basidiome.

Mean spore size and mean *Q* value of *H. berteroi:*

3.67 x 2.13 μm	1.72	Kenya, TRTC 52681
3.77 x 2.18 μm	1.73	Kenya, TRTC 52682
4.07 x 2.37 μm	1.72	Hawaii, BPI 1100595
4.30 x 2.54 μm	1.69	Kangaroo Is., BPI 329824

Hymenochaete coffeana J.C. Léger & Lanquetin, Cryptogamie, Mycol. 15: 21 (1994); Léger, Hymenochaete 95, f. 24 (1998). Figs. 18, 39

Basidiome effused, closely adnate, crustaceous, (35–)40–100 μm thick, 1–5 cm long. Hymenium smooth, light vinaceous buff (M: 10 YR 6/2; K & W: 5–6 D 3, greyish brown); margin thin, indistinct.

Tomentum and cortex absent; hyphal layer very thin or indistinct, hyphae densely compacted, subparallel; setal layer thin, hyphae ascending or erect, densely agglutinated.

Hyphal system monomitic; hyphae thick-walled, brown, 3–3.5 μm in diam. Setae not very numerous, subulate, a few 2-rooted, (15–20–)25–35(–40) x 4–6.5 μm, with tip acute, straight, usually ensheathed. In hymenium scattered small crystals; hyphidia absent; basidia clavate or subutriform, (10–)12–15 x 3.5–4.5 μm, with 4 thin sterigmata 2–3 μm long; spores ellipsoid, one side slightly concave, 3–4(–4.5) x 1.7–2.2 μm.

Known distribution and host. West-Central Tropical Africa: Central African Republic, La Maboké, Boukoko, on *Coffea robusta*.

New locality. East Tropical Africa: Uganda, Budongo Forest W of Masindi, on twigs of an angiospermic tree, 30 Jul 1966 R.F. Cain, H.D. Griffin & J.C. Krug (TRTC 52675).

Comments. According to Léger, this species is characterized by frequently 2-rooted setae; in our specimen, such setae are rare. Setae are not numerous: 4–5 per 100 μm of hymenium (Léger, 1998: 95) or 2–7, mostly 4–5(–6) (TRTC 52675). Both the known collections of this species are very thin, but obviously this is an unimportant character caused by the young age of the specimens.

Mean spore size and mean *Q* value of *H. coffeana:*

3.50 x 1.96 μm	1.78	Uganda, TRTC 52675

Hymenochaete colliculosa (Sacc.) Parmasto, Mikol. Fitopatol. 20: 375 (1986); Parmasto in Bondarceva & Parm., Clavis diagn. fungorum URSS, Aphyllophorales 1: 31 (1986); Léger, Hymenochaete 97 1998). – *Hymenochaete tabacina* var. *colliculosa* Sacc., Malpighia 10: 263 (1896). Figs. 2, 24, 43

Basidiomata perennial, effuse or with slightly elevated margins when dry, coriaceous, separable from the substrate, 0.5–1 cm diam, then confluent, 300–600 μm thick; hymenophore tuberculose (tubercles 0.2–0.5 mm in diam, 0.2–0.8 mm high), cinnamon brown or sepia (M: 7.5YR 4–5/4–7; K & W: 5–6 D–E 5, sunburn to cinnamon brown, or 5 E 5, bronze brown).

Tomentum up to 50 μm thick, cortex 25–45 μm; thick hypal layer and thickening setal layer present.

Hyphal system subdimitic or almost dimitic, setal hyphae present. Generative hyphae subhyaline, 2–3 μm diam; skeletoids with thickened walls, dark brown, 2.5–4.5 μm. Setal hyphae 60–160 μm long, 5–7 μm in diam, gradually thinning towards the acute tip; hymenial setae 80–110 x 7.5–11 μm, with acute or almost blunt tip sometimes encrusted with small granules. Basidia 18–25 x 5–6 μm, with 4 thin sterigmata; spores ellipsoid, with one side flattened, 5.5–7.5 x 3.6–4.8 μm.

Distribution and host. Middle Asia and Siberia: Pamir, Altai and Sayani Mountains and foothills; on dead twigs of *Caragana arborescens*.

Specimens studied. Middle Asia: Altai Republic, Altai Mts., Inga, Belyi Bom, alt. 500 m, 29 Jul 1977 L. Järva (TAA 92359); Altai Nature Reserve: Bele, 9 Sep 1959 E. Parmasto (TAA 8066); Karatash, alt. 500 m, 23 Aug 1959 E. Parmasto (TAA 8941); Koo, alt. 900–1000 m, 6 Sep 1959 E. Parmasto (TAA 8840 and 8836, det. Léger); Tajikistan, Peter the First Mts., Luli-Kharvi Valley, alt. 1700 m, 19 Jun 1979 B. Kullman (TAA 115080), Sauzekhar, alt. 2020 m, 25 Jun 1979 B. Kullman (TAA 115164). Siberia: Russia, Krasnoyarsk Terr., SE of Artemovsk, forest at the River Nichka, N. Martianoff 332 (L); Krasnoyarsk, City Park, 4 Feb 1918 A. Yavorski (L); Krasnoyarsk Terr., Stolby Nature Reserve S of Krasnoyarsk, 28 Aug 1971 and 11 Aug 1980 E. Parmasto (TAA 55176, 55195, 102862); Tuva Republic, East Tannu-Ola Range, SE of Mezegei, Sosnovka, 12 Jul 1972 A. Raitviir & B. Kullman (TAA 65685); East Tannu-Ola Range, Moren E of Erzin, 20 Jul 1972 B. Kullman (TAA 65809).

Comments. The similar species *H. tabacina* (Sowerby: Fr.) Lév. differs in its more or less smooth hymenium and cylindrical spores 4.2–6.3 x 1.4–2.3 μm. *H. colliculosa* is one of the few species of the genus *Hymenochaete* to have spores in almost all collections.

Mean spore size and mean *Q* value of *H. colliculosa:*

5.63 x 3.80 μm	1.48	Tuva, TAA 65809
5.80 x 3.75 μm	1.55	Krasnoyarsk Terr., TAA 55195

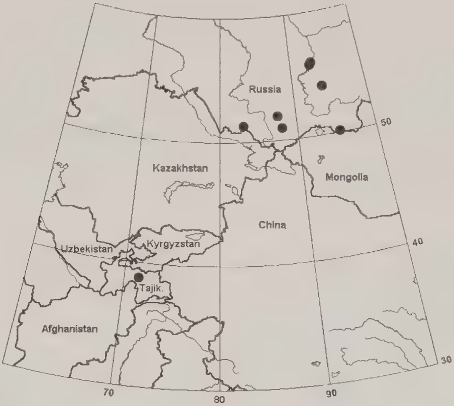


Fig. 43. Distribution of *Hymenochaete colliculosa*

6.42 x 3.97 μm	1.62	Altai Mts., TAA 8941
6.48 x 4.06 μm	1.60	Saiany Mts., L, Martianoff 332
6.49 x 4.09 μm	1.59	Altai Mts., TAA 8066
6.51 x 4.03 μm	1.62	Krasnoyarsk, L, Yavorski 569
6.58 x 4.21 μm	1.56	Altai Mts., TAA 92359
6.59 x 3.98 μm	1.66	Altai Mts., TAA 8836
6.85 x 4.66 μm	1.47	Tuva, TAA 65685
6.90 x 4.13 μm	1.67	Altai Mts., TAA 8840
7.06 x 4.37 μm	1.62	Altai Mts., TAA 115164
7.12 x 4.33 μm	1.65	Altai Mts., TAA 115080
7.23 x 4.17 μm	1.74	Krasnoyarsk, TAA 102862

Coniophora deflectens (Bres. & Sydow) Parmasto, **comb. nova – Basionym:** *Hymenochaete deflectens* Bres. & Sydow, Philipp. J. Sci. C 9 (4): 351 (1914).

Basidiome effused, loosely adnate or separable from the substrate, woody but fragile, up to 7 cm or more in diam, thick (0.5–1.5 mm), in section with 2–10 layers; hymenium smooth, with few deep cracks, tobacco or chocolate brown (M: 7.5 YR 4/3.5–4 or 5 YR 4/4; K & W: 6 E 6–7, cinnamon to raw sienna); margin distinct, abrupt, pale.

Context 200–300 μm thick, composed of almost densely subparallel intermixed hyphae, darker than the thickening hymenial layer.

Hyphal system monomitic; generative hyphae with thin or slightly thickened walls, brownish, septate, 3.5–5 μm diam, in the hymenium more or less vertically loosely interwoven. No setae. Hyphidia numerous, slightly flexuose, thin-walled and subhyaline or with thickened walls and brownish, 2–7 μm diam; basidia 45–65 x 8–12 μm, with 4 conical sterigmata 9–12 μm long; spores ellipsoid, thick-walled (walls 0.8–1.5 μm thick), brown, about 14–15 x 9–10 μm (?).

Types studied. Malesia: Philippines, Butuan subprovince, Mindanao, 13 May 1911 C.M. Weber 1286 (S, holotype; BPI 348599–348602 and 329905 = Lloyd Herb. 29736, K, LSUM, isotypes).

Comments. The type is a well developed specimen but with few collapsed basidia and only a few spores; in the original description by Bresadola and Sydow, the spores were described as 8–10 x 4–5 µm. *Coniophora dimitica* G. Cunn. *(n. v.)* may be a later synonym of this species.

A specimen very similar to *C. deflectens* has been collected in EAST TROPICAL AFRICA (Kenya, Eastern Prov., Aberdare Mts., Kimakia Forest Sta., alt. 2200–2400 m, on rotten wood, 16–18 Jan 1973 L. Ryvarden, O 9138). The only difference is in spore size: (8–)8.5–10.5(–12) x 6.5–8(–8.5) µm; mean size of 30 spores is 9.74 x 7.12 µm, *Q* = 1.37.

HYMENOCHAETE DEPALLENS Berk. & Broome, J. Linn. Soc. Bot. 14: 68 (1873); Léger, Hymenochaete 118, f. 33 (1998). – *H. fuscobadia* K.S. Thind & Adlakha in Reid et al., Trans. Brit. Mycol. Soc. 41 (1): 133 (1958). Figs. 3, 23

Basidiome effused, loosely attached, soft, thick (350-700 µm); hymenium pelliculous, deeply cracked and lacerate, yellowish grey (M: 5–10 YR 7/4; K & W: 5 B 4 or 6 C 4 to 6 B 3, raw sienna), margins of the cracked hymenium elevated; margin byssoid, whitish, then concolorous with the context; context loose, brown (M: 7.5 YR 5/7–10; K & W: 6 D 7, raw sienna).

Tomentum and cortex absent; context composed of loosely interwined generative hyphae; hymenium thickening.

Hyphae brown, with numerous septa and sidebranches, with thickened or thick walls, 3–5 µm in diam; subhymenial hyphae densely packed, brownish, with thin or thickened walls, 2.5–3.5 µm in diam. Setae scattered, narrowly conical, some curved or slightly sigmoid, with acute tip, 80–150 x (8–)9–13(–17) µm, emerging up to 50 µm above the hymenium, some sheathed. Basidioles numerous, subhyaline, 15–22 x 5–7 µm; basidia subutriform, 15–25 x 5–7 µm, with 4 thin sterigmata 4–5 µm long; spores ellipsoid, one side flattened, (5.5–)6–7.3(–7.5) x (3.5–)3.7–4.2(–4.5) µm.

Known distribution. INDIAN SUBCONTINENT: Sri Lanka.

Types studied. *H. depallens:* Sri Lanka ('Ceylon'), Centr. Province, Nov. Dec. 1868, no. 145 (K, holotype; BPI 278108, isotype). *H. fuscobadia:* INDIAN SUBCONTINENT: India, Uttar Pradesh, Mussoorie, Dhobi Ghat, on *Quercus incana,* 23 Aug 1954 K.S. Thind (K, holotype).

New localities. INDIAN SUBCONTINENT: India, Punjab, Gopalpur, Bashahar Division, 7,000 ft, 24 Oct 1941 K. Bagchee 9 (K); Himachal Pradesh, Simla, Chadwick Falls, 3 Aug 1971 S.S. Rattan 5571 (K; identified as *H. leonina* Berk. & M.A. Curtis). Nepal: Kathmandu, Daman, 11 Sep 1969 S.S. Rattan 5581 (K and BPI 348661, det. as H. *fuscobadia).* Pakistan, Changla gali, on logs, 16 Aug 1949 S. Ahmad 14849 (K). INDO-CHINA: Thailand, Cangwat Lamphun, Doi Inthanond, alt. 2200–2590 m, 17 Feb 1979 L. Ryvarden 17603 (O).

Comments. Spore measurements are slightly different in the specimens *Rattan 5571* and *Ahmad 14849* if compared with the type; however, the holotype has only a few deformed spores. Specimen *Bagchee 9* is sterile, thick, indistinctly 9-layered but otherwise typical.

Mean spore size and mean *Q* value of *H. depallens:*

6.41 x 4.13 µm	1.55	Thailand, O, Ryvarden 17603
6.42 x 3.77 µm	1.70	Pakistan, K, Ahmad 14849
6.61 x 4.00 µm	1.65	India, K, Rattan 5571
7.06 x 4.21 µm	1.68	Nepal, Rattan 5581

HYMENOCHAETE GIGASPORA D.A. Reid, Kew Bull. 29 (2) 363, f. 1 (1974); Léger, Hymenochaete 153, f. 51 (1998). Figs. 1, 21

Basidiome effused, loosely adnate, soft coriaceous, 0.3–1 cm in diam, then confluent, 80–200 μm thick; hymenium smooth, cinnamon hazel (M: 7.5 YR 6/4–6; K & W: 5 D 5, clay colour); margin narrow, slightly fimbriate, somewhat lighter coloured than hymenium, then distinctly delimited and concolorous.

Tomentum and cortex absent; context composed of a layer of more or less densely interwined hyphae with a few embedded setae (called 'setal layer' by Léger, 1998); in subhymenium and hymenium abundant crystals and granules of brownish resinous matter.

Hyphal system subdimitic; generative hyphae infrequent, hyaline, thin-walled, branched, septate, 2–3.5 μm in diam; skeletoids similar, brown(ish), with thickened walls, 2–3 μm in diam. Setal hyphae absent; setae subulate or subfusoid, 75–100(–105) x 7–10 μm, emerging up to 70(–85) μm above the hymenium, with acute tip, with a hyphal sheath; basidia utriform, suburniform or subovoid, 18–22 x 5–7 μ, with 4 conical curved sterigmata 4–5 x 1.5–2 μm; spores subsphaerical or broadly ellipsoid, (6–)6.5–8.5(–9.5) x (4.5–)5.2–6.5(–7) μm, with a prominent apiculus.

Known distribution and hosts. SOUTH TROPICAL AFRICA: Zambia, on *Baphia obovata* and *Pterocarpus angolensis* (Leguminosae).

Type studied. Zambia, Bovu, 28 Nov 1973 M.H. Ivory (K, holotype).

New locality. INDIAN SUBCONTINENT: Pakistan, Zafarwal, on *Cordia myxa* [Boraginaceae], 7-8-64 [S. Ahmad?] 18298 (BPI 299845).

Comments. Spores of the Pakistan collection are smaller than in the type, but this difference is within the limits of normal variability of *Hymenochaete* species; among the spores of the Pakistan collection, one had measurements 9.9 x 8.2 μm. Secondary septa towards the base of setae are rare in the type specimen, but absent in the Pakistan one.

Mean spore size and mean *Q* value of *H. gigaspora:*

7.23 x 5.94 μm	1.22	Pakistan, BPI 299845
9.84 x 7.03 μm	1.39	Zambia, K, holotype.

HYMENOCHAETE GLOBISPORA Escobar ex J.C. Léger, Cryptogamie, Mycol. 11: 300 (1990); Léger, Hymenochaete 159, f. 54 (1998). Figs. 5, 27

Basidiomata effused, easily detachable, soft coriaceous, up to 1 mm thick; hymenium smooth or somewhat uneven, not cracked, sienna to umber (M: 7.5–10 YR 5–6/8, later 7.5 YR 5/6; K & W: 5–6 D 7, golden brown), in the part with numerous crystals in herbarium more greyish (N: 7.5 YR 5/4; K & W: 5 D 5, clay colour); margin thinning, abrupt, slightly more yellowish.

Tomentum weakly developed, with scattered setae; cortex 15–25 μm thick; hyphal layer thick, with several (up to 7) lines of old cortex, composed of irregularly interwined hyphae; setal layer thin.

Hyphal system monomitic; hyphae brownish, with thickened walls, branched, rarely septate, 1.5–3 μm in diam. Setae narrowly fusoid, 70–100(–110) x 7–10 μm, emerging up to 75 μm above the hymenium, with acute tip, in upper part with scattered crystals, later sheathed and with conglomerates of resinous matter. Hyphidia absent; basidia with

4 sterigmata; spores broadly ellipsoid or subglobose, 4.5–5.5(–6) x 3.5–4.5 µm.

Known distribution. Western South America: Colombia, Peru.

New localities. Brazil Northeast: Brejo do Lapa, Estado Minas Gerais, 3 Apr 1966 B. Lowy 1398BR (SP 92226). Malesia: Malaysia, Sabah, Mt. Kinabalu, Liwago River trail, 1500 m, on dead, standing, moss-covered tree, 16 Dec 1985 B. Spooner K 106 (K).

Comments. Spores of the South American collections have been described by Léger (1998) as globose, 4–5.5(–6) μm in diam; however, in fig. 31 in the Escobar's dissertation (1978) and in fig. 54 in Léger's book they are figured as broadly ellipsoid or subglobose.

Mean spore size and mean *Q* value of *H. globispora:*

4.84 x 3.86 μm	1.25	Malaysia, K, Spooner K 106
5.32 x 4.06 μm	1.31	Brazil, SP 92226

Hymenochaete innexa G. Cunn., Trans. Roy. Soc. New Zeal. 85 (1): 47, f. 30 (1957); Job, Mycol. Helv. 4 (1): 24 (1990); Léger, Hymenochaete 165, f. 57 (1998). Figs. 8, 22

Basidiome effused, adnate, crustaceous hard, when old irregularly cracked, 1–3 cm in diam, later confluent and up to 10 cm long, 60–250 μm thick. Hymenium smooth, dark vinaceous buff (M: 5 YR 6/3, K & W: 6 D 3, café-au-lait), later dark umber (M: 5 YR 4/3–4 or 2.5 YR 4.5/4; K & W: 6 E 4–6, dark cocoa brown or 7 D 5, brown); margin more paler, 0.5–2 mm broad, sienna or cinnamon-sienna (M: 5 YR 7/5; K & W: 6 C 4, red-haired), later distinctly delimitated.

Tomentum, cortex and hyphal layer usually absent but sometimes basidiomata locally with thin (15–25 μm) cortex and/or with a thin (20–50, rarely up to 100 μm) hyphal layer of densely interwined hyphae.

Hyphal system subdimitic; skeletoid hyphae numerous, brown, densely agglutinated, with thickened walls, 2–3.5(–5) μm in diam; generative hyphae rare (mainly in the marginal part of the basidiome), thin-walled, septate, 2.5–4 μm in diam. Setae infrequent, with very thick walls, 50–70(–75) x 7–12(–15) μm, emerging up to 50 µm above the hymenium, with almost blunt tip, usually sheathed, when old encrusted with amorphous resinous matter. Hyphidia very numerous, slightly conical, usually slightly sinuose, subhyaline, soon brown, with thickened walls, 15–25 x 2.5–4 μm; basidia slightly subutriform, 18–25 x 4–5 μm, with 4 thin sterigmata; spores ellipsoid, with one side flattened or slightly concave, 4.5–6.3(–7) x 2–3 μm.

Known distribution and hosts. Australasia: New Zealand, on *Griselinia* sp. sp. and *Fuchsia excorticata;* North-Central Pacific: Hawaii.

Types studied. New Zealand, Wellington, Mt. Hauhangatahi, Feb 1952 G.H. Cunningham, PDD 16627 (BPI, K, isotypes).

New localities. China: Taichung, Kenting, 20 Feb 1992 S.H. Wu 9202-20 (TAA 171415). Eastern Asia: Japan, Prov. Iwashiro [?], 20 May 1916 A. Yasuda 375 (BPI 277497, Lloyd Herb. 377). Indian Subcontinent: India, Tamil Nadu, Tirunelveli Distr., Kalakad Sanctuary, 900 m, on a dead twig of *Swietenia mahagoni* and on fallen trunks of angiosperms, 12–15 Feb 1979 E. Parmasto and G. Sekar (TAA 103187, 103316, 103126, 103273). Australia: Victoria, Mt. Torbreck near Eildon, about 1000 m, on eucalypt log, 11-3-1976 K. & G. Beaton K.106 (K).

Comments. The description given above is based mainly on the Indian and Australian collections; the Japanese specimen is a small part of a basidiome, but with well-developed microstructure: hyphidia are with thickened walls, brownish, 2–3 μm in diam. The Australian specimen has few spores 4.4–5.8 x 2.0–2.8 μm. In the isotype (K), only a few spores about 6 x 2.8 μm were found; Léger has studied the type and found the spores to be 5.2–6 x 2.2–2.5 μm, i.e., smaller than described by Cunningham.

Structure of the basidiomata is quite variable in this species: in some specimens, the hyphal layer is hardly distinguishable, in other cases or in some parts of a basidiome it is well developed and hyphae are almost loosely interwoven; in some parts of such basidiomata a thin but distinct cortex may be seen. Accordingly, the species may be included within the subgenera *Gymnochaete, Fultochaete* or *Paragymnochaete.*

Mean spore size and mean *Q* value of *H. innexa:*

4.78 x 2.14 μm	2.23	India, TAA 103220
4.86 x 2.32 μm	2.09	India, TAA 103273
5.75 x 2.51 μm	2.29	India, TAA 103316
5.76 x 2.48 μm	2.32	India, TAA 103126
5.79 x 2.47 μm	2.34	Japan, BPI 277497

HYMENOCHAETE LIGNOSA G. Cunn., Trans. R. Soc. New Zeal. 85 (1): 38, f. 22 (1957); Léger, Hymenochaete 179, f. 64 (1998) = **H. UNICOLOR** Berk. & M.A. Curtis

Basidiomata of the isotypes are effused, adnate, woody hard, very thick, in section indistinctly multilayered; hymenium dark brown (M: 5 YR 3/2 to 2.5 YR 4/3; K & W: 6–7 E 4–5 to 6 D 6); margin abrupt, blackish.

Hyphal layer thin, composed of densely agglutinated thick-walled brown hyphae 2.5–3 μm diam; setal layer thickening, hyphae densely vertically agglutinated. Setae 40–55 x 8–9 μm; basidia few, 12–15 x 4–5 μm; the few spores seen are about 5 x 2.8–3 μm.

Known distribution and hosts. AUSTRALASIA: New Zealand, on a decaying trunk of *Nothofagus fusca* (only type locality known).

Types studied. New Zealand, Nelson, Staircase Creek, Reefton, alt. 700 m, 2 Dec 1952 S.D. Baker, PDD 16637 (K, BPI, isotypes).

Comments. The only difference from *H. unicolor* indicated by Léger (1998) is the seemingly pseudoparenchymatic structure of the context in *H. lignosa;* in the isotypes studied by me, this structure is hardly different from the context of *H. unicolor.*

HYMENOCHAETE LIVENS Bres., Hedwigia 56: 302 (1915); Léger, Hymenochaete 181, f. 65 (1998).

Basidiomata efused, adnate, crustaceous hard, 1–1.5 mm thick; hymenium smooth, tobacco brown (M: 10 R (3–)4/4), in some parts covered with greyish film; in section indistinctly layered; margin abrupt, slightly darker than the hymenium.

Only setal layer present; hyphae densely vertically agglutinated.

Setae very numerous, with blunt or rounded tip, 70–80 x 10–20 μm, heavily encrusted with small granules. Hyphidia indistinct, brownish or brown, with thickened uneven walls, 1.5–2(–2.5) μm diam; no basidia or spores seen.

Known distribution and hosts. MALESIA: Philippines (only type locality known).

Type studied. Philippines, Polillo, Oct–Nov 1909 McGregor, Bureau of Science no. 10536 (S, holotype).

Comments. Only one old, sterile specimen of this species is known. There are no good characters to distinguish this taxon from other species or to assert its conspecificy with other, maybe fertile specimens which may be found in future. *H. livens* is a dubious species and the name should no longer be used.

Hymenochaete magnahypha G. Cunn., Trans. Roy. Soc. New Zeal. 85 (1): 45 (1957); Job, Mycol. Helv. 4 (1): 28 (1990); Léger, Hymenochaete 188, f. 68 (1998). Fig. 30

Basidiome effused, closely adnate, woody hard, up to 10 cm long, 100–180 µm thick; hymenium smooth, irregularly, later deeply cracked, colour between dark brick and sepia (M: 5 YR 5/3; K & W: 7-8 E 4, henna); context dark brick (M: 5 YR 4.5/4); margin indistinct.

Tomentum and cortex absent; hyphal layer composed of more or less parallel densely interwined hyphae; setal layer present, thickening.

Hyphal system monomitic; hyphae brown, with thick walls, branched, 3–6 µm in diam. Setal hyphae (embedded setae) present or locally absent, rare, 60–90 x 8–10 µm, bending towards hymenium; hymenial setae very numerous (crowded), broadly fusoid, with very thick walls, 25–40(–50) x 7–10(–14) µm, brown, upper part and almost blunt tip covered with a conical subhyaline granulose cap, slowly dissolving in KOH solution. Basidioles present; basidia hyaline, subutriform, 15–20 x 4–5 µm, with 4 thin sterigmata about 4 µm long; spores cylindrical, curved, 7.8–9.5 x 2.6–3.0 µm.

Known distribution and hosts. Australasia: New Zealand, on *Coprosma australis* (Rubiaceae).

Type studied. New Zealand, Auckland, Little Barrier Is., House Creek, on *Coprosma australis*, 20 Nov 1947 J.M. Dingley, PDD 5916 (K, isotype).

New locality. China: [Guangdong ?], Kiulunghsien, S[h]ikang, on fallen twigs of frondose species, 5-12-39 S.C. Teng 3308 (NY).

Comments. Spores of the New Zealand specimens are somewhat shorter and broader, and setae of slightly smaller diameter (Léger, 1998, p. 189: 7.5–8.5 x 3–3.5 µm; 5–6 µm), but the difference is within the limits of normal variability in *Hymenochaete*. *H. magnahypha* is one of the two species known with large cylindrical spores and short setae; the possibly closely related South American *H. crassisetosa* Parmasto differs in its smaller spores (6–)6.3–7.2(–7.5) x 2.1–2.5(–2.7) µm, densely agglutinated hyphae 3–3.5(–4) µm in diam and setae of very large diameter, 10–15(–18) µm.

Mean spore size and mean *Q* value of *H. magnahypha:*

8.73 x 2.87 µm	3.04	China, NY, Teng 3308.

Hymenochaete microspora Welden ex J.C. Léger, Cryptogamie, Mycol. 11 (4): 365 (1990); Job, Rev. Inv. Agrop. INTA 20 (1): 143–165; Léger, Hymenochaete 190, f. 69 (1998). Figs. 11, 28

Basidiome effused, adnate; hymenium smooth, when old somewhat cracked, cinnamon or dark greyish cinnamon (5 YR 5/3 – 5/7; K & W: 6 D 4–7, camel, cinnamon or raw sienna); margin 0.5–1 mm in width, lacerate-fibrillose or tomentose, light cinnamon, soon indistinct.

Known distribution and hosts. South America: Argentina, Colombia, Ecuador.

New localities. Northern South America: Venezuela (O 42774). Southern South America: Argentina, Misiones, Iguazi Nat. Park, 9 Oct 1984 Wright et al. M-3716 (BAFC 30323, det. Job).

Comments. This species is very closely related or possibly conspecific with *H. raunkiaeri*. The main difference is in the structure of hymenophore: tuberculate in *H. microspora*, smooth in *H. raunkiaeri*.

Mean spore size and mean *Q* value of *H. microspora:*

3.66 x 2.14 µm	1.71	Venezuela, O 42774
4.19 x 2.31 µm	1.81	Argentina, BAFC 30323

Hymenochaete mollis Bres., Hedwigia 56: 302 (1915); Léger, Hymenochaete 193, f. 71 (1998).

Basidiomata pileate, reniform or dimidiate, up to 6(–8) cm broad, 0.5–1.5 mm thick, cottony, very soft and lightweight, fragile; pileal surface uneven, soft but not velvety, shallowly concentrically sulcate, dark tobacco brown (M: 5 YR 4/7); margin thick; hymenial layer uneven, soft, concolorous with the pileal surface.

Tomentum and cortex absent; context composed of loosely interwined hyphae; four alternate setal (hyphidial) layers with a thin layer of hyphae between these in the type specimen.

Hyphal system monomitic; hyphae brownish, with thickened walls, frequently branched (mostly just less than right-angled), septate, 4–6(–7) µm in diam. Setae infrequent, subulate, (40–)50–65 x (4.5–)5.5–8 µm, sheathed, with acute tip. Cystidia absent, basidia and spores not seen; setal layers composed of a palissade of cylindrical brownish acanthohyphidia 60–120 µm long and 4–6 µm in diam, with thickened, in distal part thin walls, covered with dense, small, bent downwards thorns 0.5–1.5 x 0.5 µm.

Types studied. Malesia: Philippines, Is. Polillo, Aug 1909 C.B. Robinson, Bureau of Science 9104 (S, holotype; S, BPI 278243, 278244, NY and LSUM, isotypes).

Comments. Only one specimen of this curious species has been collected. Long hyphidia of similar structure have been observed in the hymenium of *H. tuberculosa* and sometimes also in *H. cinnamomea* ssp. *spreta*, but they are never so long and with such big thorns in these species. Basidiomata of *H. mollis* are very fragile and so large that it seems to be impossible they are growing horizontally without being broken. Possibly the seemingly pileate basidiomata collected by a non-mycologist have actually been effused and very loosely attached to the substrate. If this is the case, this species and *H. tuberculosa* may be very closely related.

Hymenochaete murina Bres., Ann. Mycol. 18 (1–3): 46 (1920); Léger, Hymenochaete 197 (1998). – *H. fomitoporoides* S. Ito & Imai, Trans. Sapporo Nat. Hist. Soc. 16: 129 (1940); Ito, Mycol. fl. Japan II 4: 163 (1955); Léger, Hymenochaete 143, f. 47 (1998). – *H. amboinensis* s. J.C. Léger, Hymenochaete 53, f. 8 (1998), *nom. seminudum.* Figs. 7, 41

Basidiome effused, adnate, soon confluent and up to 15 cm long, 60–200(–500) µm thick, woody hard. Hymenium smooth, sometimes with a few deep cracks, when spore-bearing or growing from hymenium hyphae very pale vinaceous grey or ash gray (M: 5 YR 6/1; K & W: 6 C–D 1, grey), then umber or greyish umber (dark brown) (M: 5–7.5

YR 4/4 or 7.5 YR 4–5/6; K & W: 6 E 4–7); margin thin, farinose, paler (M: 1 YR 4/3; K & W: 6–7 E 5, somalis), then almost indistinct.

Context a dense setal layer composed mainly of brown acanthohyphidia agglutinated with resinous matter.

Hyphae 2–4 μm in diam, indistinct, agglutinated; setae infrequent (in some parts of hymenium sometimes numerous), broadly conical, (25–)35–50(–60) x 7–14 μm, emerging 10–25 μm above the hymenium, acute or almost blunt, usually sheathed. Acanthohyphidia crowded, with thickened brown walls, 15–30(–40) x 2–3.5(–4) μm, in upper part with numerous horisontal short denticles 0.5–1.5 μm long, some acanthohyphidia with 2–3 longer denticles up to 4 μm long simulating dendrohyphidia; basidia 3–4 μm in diam; spores cylindric, with one side slightly concave, (4.2–)4.4–6.0(–6.5) x (1.8–)1.9–2.4 μm

Known distribution. Eastern Asia: Japan (Bonin Is., Ogasawara); Malesia: Philippines.

Type studied. *H. murina:* Philippines, Prov. Laguna, Luzon, 1915 R.C. Mc Gregor (S).

New localities. Eastern Asia: Taiwan, Ilan, Kungliao, 25 Jul 1991 Y.F. Lin 564 (TNM, TAA). Indo-China: Thailand: Changwat Chiang Mai, Amphoe Mae Rim, Kong Hae, 800 m, 15 Feb 1979 L. Ryvarden 17565 (O), Khao Yai Nat. Park, Tad Tha Phu, 5 Aug 1997 U. Kõljalg (TAA 159607), Ko Samui, Chaweng Noi, on branch of dead deciduous wood, 15 Feb 2002 F. Dämmrich 6054 (TAA). Malesia: Philippines, Luzon, Lamao (Mt. Mariveles), [on bamboo,] Nov 1904 Elmer 6953 sub *H. pellicula* (S, K, BPI 278280, 278292); Luzon, Rizal, Oct 1912 M. Ramos (BPI 329818, Lloyd Herb. 6504); Luzon, Sorsogon Prov., Ironsin, Mt. Bulusan, Apr 1916 E. Elmer 15879 (BPI 1100593); Philippines, Merrill 13462, identified by G. Bresadola as *H. amboinensis* P. Henn. (ined.) *forma* (S); Singapore, Blakang Mati, on dead mangrowe below high tide mark, 27 Dec 1919 T.F. Chipp (K(M) 55405). Indian Subcontinent: India, Tamil Nadu, Tirunelveli Distr., Kalakadu Sanctionary, 900 m, 13 Feb 1979 E. Parmasto (TAA 103202); Mundanthurai Sanctuary, Kodimudi plantation area, on a fallen rotten angiospermic twig, 18 Feb 1979 G. Sekar (TAA 103432, det. E. Parmasto).

Comments. *H. amboinensis* s. Léger, *H. fomitiporoides* and *H. murina* have been described as three very closely related species; most collections studied by me (except the Indian and Taiwanese ones) are sterile or only with a few spores. According to Léger (1998), *H. amboinensis* differs from *H. fomitiporoides* by its slightly smaller setae, *H. murina* from both species by the absence of crystals and by its ash grey or reddish brown basidiomata. However, the greyish colour and absence of crystals depend on the state of development of the hymenium, as it is usual in many *Hymenochaete* species. Variability of setal size is within normal limits in all specimens described by Léger or studied by me.

A closely related sibling species *H. acanthophysata* has been found in Africa (see above). The main difference is the presence of an indistinctly differentiated hyphal layer composed of densely agglutinated hyphae, and slightly smaller spores (4.0–)4.2–5.0(–5.2) x 1.5–2 μm.

Mean spore size and *Q* value of *H. murina:*

4.50 x 1.98 μm	2.27	India, TAA 103202
5.22 x 2.20 μm	2.37	Taiwan, TNM, Lin 564
5.35 x 2.12 μm	2.53	India, TAA 103432

HYMENOCHAETE MUROIANA Hino & Katumoto, Icon. fung. bamb. Jap. 237 (1961); Léger, Hymenochaete 198, f. 73 (1998). Figs. 16, 35

Known distribution. EASTERN ASIA: Japan, on bamboo.

New localities. INDO-CHINA: Thailand, Khao Yai Nat. Park, Phakrajai, on dead bamboo, 6 Aug 1997 U. Kõljalg (TAA 159658). MALESIA: Philippines, Province of Rizal, Luzon, Feb 1911 M. Ramos (S, no. 13460, identified by G. Bresadola as *H. pellicula* Berk. & Br.; BPI 348281, 348591); Sulawesi, Eastern Dumoga, Bone Nat. Park, on an angiosperm twig, 18 Oct 1985 G.J. Samuels 2282 (NY).

Comments. The Philippines specimen has a brown hymenium (M: 7.5 YR 6.5/6), is 75–130 μm thick and has T-shaped setae 30–35(–45) x 7–10 μm; the Sulawesi specimen was growing on a substrate other than bamboo and is lighter coloured (greyish cinnamon; M: 10 YR 7/4–6/6, K & W: 5 C 4, brownish orange) but otherwise typical (setae 25–45 x 6–8 μm, partly with T-shaped base; spores few, ellipsoid, 3.2–3.7 x (1.9–)2.2–2.4 μm).

HYMENOCHAETE OCHROMARGINATA P.H.B. Talbot, Bothalia 4: 944 (1948); Job, S. Afr. J. Bot. 53 (4): 296 (1987), Mycol. Helv. 4 (1): 30 (1990); Léger, Hymenochaete 202 (1998); Härkönen, Niemelä, Mwasumbi, Norrlinia 10: 171 (2003). Figs. 17, 32

Basidiomata effuso-reflexed or sessile-pileate, densely coriaceous when dry, up to 1.5(–2) mm thick. Pilei usually imbricate to confluent, sometimes in rosettes, a few single, dimidiate or flabelliform, 1-3 cm long, up to 4.5 cm broad, radially brittle when dry; pileal surface densely concentrically sulcate and zonate, tomentose to strigose, fulvous umber (M: 5 YR 5/6–7; K & W: 6 D–E 5, sunburn or light brown); margin thin, entire, lighter coloured than the pileal surface, then concolorous. Hymenium smooth but in old specimens faintly zonate, not cracked, dark hazel to greyish sepia (M: 5 YR 4/3; K & W: 6 E 4–5, cocoa brown), with a fulvous margin 1–2 mm broad when young (M: 5 YR 6.5/7–8; K & W: 6 C 5, sahara), later concolorous with the hymenial surface.

Tomentum present, thick (up to 1 mm); cortex present; context composed of radially situated hyphae, in section not glossy; setal layer absent in young specimens. Setae subulate, 30–55(–60) x 6–8.5 μm; spores ellipsoid, some with one side slightly flattened, 3–4(–4.3) x 1.8–2.8 μm.

Known distribution and hosts. SOUTHERN AFRICA: Natal, Transval, Tembuland; EAST TROPICAL AFRICA: Tanzania; INDO-CHINA: Thailand; everywhere rare. On angiospermic trees incl. *Erica arborea, Hagenia abyssinica* a.o. (Härkönen *et al.*, 2003).

New localities. EAST TROPICAL AFRICA: Uganda, Budongo Forest W of Masindi, 3500 ft., 30 Jul 1966 R.F. Cain, H.D. Griffin & J.C. Krug (TRTC 52692); Tanzania, Mt. Kilimanjaro Forest Reserve, 8000 ft., 15 Aug 1966 R.F. Cain, H.D. Griffin & J.C. Krug (TRTC 52695); Mt. Kilimanjaro, Upper edge of heath, 9300 ft., 15 Aug 1966 R.F. Cain, H.D. Griffin & J.C. Krug (TRTC 52693); Aruskaheg, western Mt. Meru, Laikinoi, alt. 2800 m, on *Hagenia abyssinica,* 14 Dec 1988 T. Niemelä 5122 (H). INDIAN SUBCONTINENT: Sri Lanka, Hakgala, 1910 Petch, det. Talbot (K).

Comments. Basidiomata of *H. ochromarginata* are similar to those of *H. luteobadia* (Fr.) Höhn. & Litsch., *H. rubiginosa* (Dicks.: Fr.) Lév. and *H. villosa* (Lév.) Bres.: all four species have well developed pilei of similar structure (tomentum, cortex, context and setal layer present; spores small, ellipsoid; setae rather small). *H. luteobadia* differs in the greyish ochraceous colour of hymenium and presence of brownish hyphidia with thickened walls; *H. rubiginosa* has more rigid and hard basidiomata, bigger setae 40–80(–100) x (6–)8–10(–12) μm and spores (3.5–)3.8–5.5 x (1.8–)2.2–2.8(–3) μm, possibly its distribution in Africa is limited to the northern part; *H. villosa* has similar setae and spores to *H. ochromarginata*, but there are submonilioid hyphal ends present in its hymenium, and it has a context which is glossy in section. A difference in thickness of the setal layer indicated by Léger (1998), up to 80 μm in *H. villosa* and 400–700 μm in *H. ochromarginata*, depends on the age of basidiomata, and is possibly unimportant as a taxonomical character. These two taxa are obviously very closely related allopatric sibling species with only partly overlapping areas of distribution (*H. villosa* has been found in Asia-Tropical and Australasia, possibly also in Chile (South America), *H. ochromarginata* in Africa and Sri Lanka).

Mean spore size and *Q* value of *H. ochromarginata:*

3.49 x 2.11 μm	1.65	Tanzania, H, Niemelä 5122
3.58 x 2.10 μm	1.70	Tanzania, TRTC 52695
3.67 x 2.38 μm	1.54	Uganda, TRTC 52692

HYMENOCHAETE PECTINATA (Bres.) Parmasto, **comb. nova** – **Basionym:** *Hymenochaete ferruginea* (Bull.) Bres. var. *pectinata* Bres., Hedwigia 53: 77 (1913).

Basidiomata pileate, thin, flabellate, similar to *H. villosa* but distinctly different in its numerous acanthohyphidia, which have small teeth up to 1 μm long in the upper part.

Known distribution. MALESIA: Philippines.

Type studied. Philippines, Davao, Mindanao, 14 Mar 1904 Copeland 523 (S, lectotype designed here).

Comments. This is the only known truly pileate *Hymenochaete* species with acanthohyphidia. Three collections of this new variety of *H. ferruginea* were indicated by Bresadola (1913: 77) in his description, but I could not find the two others (Copeland 495 and *Bureau of Science* 10545) in Bresaola's herbarium in S. The lectotype of the var. *pectinata* was later re-identified by him as *H. subpurpurascens* (Berk. & Broome) Bres., and Léger (1998: 268, 270) followed his synonymization.

HYMENOCHAETE PELLICULA Berk. & Broome, J. Linn. Soc. Bot. 14: 65 (1873); Léger, Hymenochaete 214, f. 81 (1998).

Hymenium brown (M: 7.5 YR 5/4; K & W: 6 D 4, camel); spores 5–6.3 x 3.5–4.2 μm.

Known distribution. INDIAN SUBCONTINENT: Sri Lanka.

Holotype studied. Sri Lanka ('Ceylon'), Central Province, Jan 1869, no. 990 (K).

Comments. The collections from the Philippines identified by Bresadola as *H. pellicula* Bres. belong to *H. muroiana* (S, no. 13460) and *H. murina* (S, Elmer no. 6953; Bresadola, 1915: 302).

HYMENOCHAETE PLURIMISETAE G. Cunn., Trans. R. Soc. New Zeal. 85 (1): 27 (1957), '*plurimaesetae*'; Job, Mycol. Helvet. 4 (1): 33 (1990); Léger, Hymenochaete 222, f. 85 (1998). – *H. floridea* Berk. & Broome *sensu* G. Cunn., Trans. R. Soc. New Zeal. 85 (1): 25 (1957). Figs. 9, 33

Basidiomata effused, adnate, with usually slightly elevated margin, 0.3–2 cm in diam, soon confluent and up to 5 cm long, 150–450 μm thick, densely coriaceous, crustaceous and brittle when old. Hymenium smooth, later with a few small or some deep cracks, cocoa brown, light chestnut or dark brown (M: 2.5–5 YR 4/4–6 or 7.5 YR 4/5; K & W: 6 E 4–6 or 7 E 5, cocoa brown or somalis); margin 0.3–1 mm broad, distinct, slightly lobed, light (M: 7.5 YR 7/8; K & W: 6 B 4, greyish orange), then concolorous with the hymenial surface.

Tomentum sometimes present as infrequent short bundles of hyphae, rarely up to 50 μm thick; cortex 20–35 μm thick; hyphal layer composed of rather loosely radially situated hyphae; setal layer dense, thickening with age.

Hyphal system subdimitic; hyphae brownish or brown, rarely septate, with thickened or thick walls, 3.5–4.5(–5) μm in diam. Setae very numerous (crowded), fusoid, attenuating to a stem-like base, (35–)40–50(–55) x (5–)6–9(–10) μm, with a blunt or almost rounded tip, covered in upper part with thin granulose incrustation (coarsely verruculose); above the setal layer a few horizontal setae (setal hyphae) 35–50 x 7–9 μm; basidia hyaline, 18–25 x 4–4.5 μm; spores cylindrical, curved (allantoid), 4.5–5.5 x 1.3–1.8 μm

Known distribution and hosts. AUSTRALASIA: New Zealand, on wood and dead branches of *Coprosma cuneata, Leptospermum ericoides, L. scoparium, Nothofagus cliffortioides* and *Phyllocladus alpinus*.

Types studied. New Zealand, Wellington, Kaimanawa Ranges, on *Coprosma cuneata,* 19 Dec 1955 G.H. Cunningham PDD 16540 (BPI 348590, K, isotypes).

New localities. AUSTRALASIA: New Zealand, Taupo, Mt. Hauhungatahi, on *Weinmannia racemosa,* Feb 1951 G.H. Cunningham (PDD 10598); Taupo, Mt. Tongariro, 2700 ft, *Podocarpus ferrugineus,* Mar 1952 G.H. Cunningham (PDD 11256); Stewart Is., Horse Shoe Bay, *Fuchsia excorticata* and *Carpodetus serratus,* Feb 1954 J.M. Dingley (PDD 16559, 16565); Bay of Plenty, Lake Rotoehu, 1200 ft, *Beilschmiedia tawa* and *Lophomyrtus bullata,* Oct 1956 and Sep 1954 G.H. Cunningham (PDD 16641, 16580); Southland, Catlin's, Lake Wilkie, *Muehlenbeckia australis,* 14 Apr 1957 S.D. & P.J. Brook (PDD 18433), all identified by Cunningham as *H. floridea* Berk. & Broome; Wellington, Kaimanawa Ranges, on *Nothofagus cliffortioides,* 23 Jan 1955 G.H. Cunningham PDD 16342 (BPI 348589, DAOM, K).

Comments. Léger (1998: 142) was the first to indicate that Cunningham's *H. floridea* is different from the type of this species, described from Sri Lanka (Ceylon). Cunningham (1957: 28) described his new species *H. plurimisetae* as resembling *H. floridea* [sensu G. Cunn.] in microfeatures but different in the ferruginous, reddish-brown, often with a purple tinge, or cinnamon colour of the hymenial surface, absence of a differently coloured margin, and presence of a brittle context. As is usual in most species of *Hymenochaete*, the colour of the margin depends on the age of the basidiome, and colour of the hymenium is quite variable. Context is brittle in the specimens with thick setal layer but not so when this layer is thin (in younger specimens). I cannot see any significant differences between these two taxa described by Cunningham.

The horizontal setae characteristic for *H. plurimisetae* are infrequent and difficult to observe; some hymenial setae have a short horizontal base (are downwards bent). In the specimens studied, spores are few, mostly collapsed and then abnormally narrow; maybe, this is the reason why Cunningham (1957: 26) indicated spore size 4–5 x 1 μm for his *H. floridea*.

Mean spore size and *Q* value of *H. plurimisetae:*

4.75 x 1.45 μm	3.29	New Zealand, PDD 18433
5.16 x 1.60 μm	3.23	New Zealand, PDD 16559

HYMENOCHAETE RAUNKIAERI Bres., Ann. Mycol. 18: 45 (1920); Léger, Hymenochaete 229, f. 87 (1998). Figs. 20, 36

Basidiomata effused, adnate, thin (75–200 μm), even, soft, cinnamon umber (M: 10 YR 5/4; K & W: 6 D 5, sunburn).

Context hyphae loosely interwoven, with slightly yellowish or brownish thickened walls, septate, branched, 2.5–3.5(–4) μm. Setae numerous, slender, acualeate or slightly fusoid, 25–50(–60) x 4–6.5(–7.5) μm, some with slightly curved tip; hyphidia and thick-walled basidioles absent; basidia 12–20 x 3.5–4 μm; sterigmata 4, 2–3 μm long; spores ellipsoid, with one side slightly flattened or almost concave, (2.8–)3–4 x (1.6–)1.8–2.5 μm.

Known distribution. CARIBBEAN.

Types studied. CARIBBEAN: US Virgin Is., St. John, 17 Mar 1906 C. Raunkiaer 30 (S, lectotype designated here; isolectotype: BPI 278322); US Virgin Is., St. Thomas, 1 Dec 1905 C. Raunkiaer (S, paratype); on bark of angiosperm trees.

New localities. CENTRAL AMERICA: Costa Rica, La Selva Biological Station, Heredia, on dead deciduous wood, 5 Jul 1999 K. Hagerud 176 (O, TAA 151356). CARIBBEAN: British Virgin Is., Guana, Iguana Head, on a fallen branch, 5 Oct 2001 P.J. Roberts GA813 (K(M) 90743). BRAZIL SOUTHEAST: Sao Paulo, Parque do Estado, 10 May 1968 B.V. Skvortzov 1404 (LSUM 2352).

Comments. Bresadola did not see any spores in the two specimens studied by him. Léger studied the (lecto)type and described these as 3–4 x 2 μm. I have seen few spores 3.5–4 x 2–2.5 μm in the isolectotype (BPI), infrequent spores 3.2–3.5 x 2.2–2.5 μm in Roberts' specimen, few spores 2.8–3.3 x 1.6–2.1 μm in Skvortzov's one and numerous spores 2.8–3.6 x 1.6–1.9 μm in Hagerud's specimens. The new collections have setae shorter than in the lectotype (20–)25–40(–45) x 4–7 μm. *H. microspora,* which differs in its tuberculate hymenium, is closely related if not conspecific with *H. raunkiaeri.* Another possibly closely related species, *H. epichlora,* differs in densely interwoven context hyphae and rare or scattered setae.

More problematic is the relationship between *H. raunkiaeri* and *H. muroiana*. The latter species differs in broader setae (25–)30–40 x 6–8 μm, subutriform basidia 5–7 μm in diam, densely interwoven hyphae and bamboo species as a substrate.

Mean spore size and *Q* value of *H. raunkiaeri:*

3.20 x 1.68 μm	1.91	Costa Rica, TAA 151356

HYMENOCHAETE SEPARABILIS J.C. Léger, Bull. Soc. Mycol. France 97: 6 (1981); Léger, Hymenochaete 252, f. 96 (1998). Figs. 10, 31

Basidiomata effused, adnate, 0.5–2.5 cm in diam, then confluent and up to 10 cm long, 60–150(–200) μm thick, coriaceous. Hymenium smooth, not cracked, fulvous cinnamon (M: 5 YR 5/6; K & W: 6 C–D 4-6, light brown); margin thinning, farinose, gradually lighter coloured (5–7.5 YR 7–8/6; K & W: 5 B 5 or 6 C 3–4).

Tomentum and cortex absent; context composed of loosely interwined hyphae, sometimes with big conglomerates of crystals 12–20 μm in diam.

Hyphal system subdimitic; generative hyphae with thin hyaline or slightly thickened brownish walls, septate, richly branched, 2–3.5 μm in diam; skeletoids with thickened walls, brown, 2–3 μm in diam. Setae infrequent, narrowly conical, (20–)30–40 x 4–6.5 μm, emerging 10–30 μm above the hymenium, acute, with easily broken tip, in upper third with few (1–3, rarely 5) conical teeth less than 1 μm high, some setae without teeth. Basidioles numerous, subhyaline or with slightly yellowish rough walls, 20–25 x 3.5–4.5 μm, with rounded tip; basidia with slightly thickened walls rugose at base, 12–18(–20) x 4–5.5 μm, with 4 sterigmata; spores ellipsoid, 3.3–4.2 x 1.5–1.7 μm.

Known distribution and hosts. AFRICA: Central African Republic, Gabon, Madagascar, Mauritius and Réunion; on *Calamus* sp., *Elaeis guinensis, Eremospatha macrocarpa* and *Senecio ambavilla* (Léger, 1998: 252).

> **New localities.** CHINA: Fukien, Chang-chow, 2 Aug 1933 S.C. Teng 2239 (BPI 278122, identified by S.H. Ou as *H. epichlora).* EASTERN ASIA: Japan, Sendai, on *Quercus glandulifera,* A. Yasuda 17 Oct 1919 (BPI 278293, identified as *H. pellicula);* on *Quercus glandulifera,* 17 Oct 1919 A. Yasuda 105 (BPI 277539, identified as *H. arida* Karst.; possibly a part of the collection no. 278293). MALESIA: Malaysia, Singapore, Blakang Mati, dead mangrove below high water mark, 24 Dec 1919 T.F. Chipp 5461 (BPI 329800). NORTHWESTERN PACIFIC: Hawaii (Parmasto & R.L. Gilbertson *in litt.).* WEST TROPICAL AFRICA: S. Nigeria, on dead leaves of Oil Palm [= *Elaeis guinensis*], 1914 Farquharson 4 (K).

Comments. The specimens collected in Japan and Hawaii were growing on bark of tree branches, an unusual substrate for this species.

There are three very closely related or possibly synonymous species: *H. palmicola* S. Ito & Imai (cf. Léger, 1998: 252), *H. separabilis* and *H. tomentelloidea* Gilb. & Hemmes. The last named species differs in having setae (35–)40–70 μm long and 5–10 broadly conical teeth 0.8–1.5(–2.0) μm long. The type of *H. palmicola* has not been restudied; if conspecific with *H. separabilis,* its name has priority.

Mean spore size and *Q* value of *H. separabilis:*

3.52 x 2.11 μm	1.67	Japan, BPI 278293
4.07 x 2.60 μm	1.56	Japan, BPI 278122

HYMENOCHAETE SPHAEROSPORA J.C. Léger & Lanquetin, Bull. Soc. Mycol. France 103: 48 (1987); Léger, Hymenochaete 262, f. 101 (1998). Figs. 4, 25

Basidiome perennial, effused, closely adnate, woody hard when dry, stratose when old, 0.2–3 mm thick, in section with up to 7 thin blackish lines. Hymenium smooth, later with a few deep cracks, when young dark sienna or mouse grey (M: 5 YR 5/6; K & W: 6 D 5, light brown), in middle greyish (M: 5 YR 6/2; K & W: 6 D 3, greyish brown), when old dark brick umber or brownish grey (M: 5 YR 5/4 or 2.5 YR 7/2; K & W: 6 D 4, camel or 6 C 2, greyish sepia); margin narrow, arachnoid, greyish (K & W: 6 D 3 – 6 C 2, greyish brown), soon abrupt, distinctly delimited, then rounded.

Tomentum absent; cortex present as a thin black line 20–50 μm thick at the base of the basidiome; hyphal layer absent; setal layer thickening, composed of erect or descending, later densely agglutinated hyphae.

Hyphal system monomitic; hyphae brownish, thick-walled, 2–3.5 μm in diam. Setae numerous, (60–)70–110(–120) x 12–20(–22) μm, projecting to 50 μm above the hymenium, fusoid, with almost blunt tip, enmeshed in hyphal sheaths, in old specimens heavily encrusted. In hymenium crystals present; hyphidia brown, with thickened walls, sinuate or somewhat irregular in form, with an acute tip, 40–60 x 2–3(–4) μm; basidioles 30–40 x (3–)4–5.5 μm, yellowish; basidia subclavate or almost subutriform, (25–)30–40 x 5–7 μm, with 4 thin sterigmata 5–6 μm long; spores broadly ellipsoid, usually with a big yellowish guttula, (5–)5.3–6.5(–7) x (3.7–)4–5(–5.2) μm,

Known distribution. WESTERN INDIAN OCEAN: Réunion (only locality).

Type studied. Réunion, forèt de Bèbour, 12 Aug 1973 A. David (LY 7232, isotype).

New localities. NORTHEAST TROPICAL AFRICA: Ethiopia, Arussi Prov., Munessa forest, E of Lake Langano, 2400 m, on dead hardwood, 15 Jul 1990 L. Ryvarden 28384, 28423 (O); Ethiopia, on *Podocarpa,* Adane 47 (LY 18669); on *Olea africana*, Adane 44 (LY 18666); on *Juniperus* sp., Adane 13 (LY 18636). WEST-CENTRAL TROPICAL AFRICA: Cameroon, Campo prov., Akok lowland rain forest reserve, 2–15 Dec 1991 Núñez & Ryvarden 31155 (O). WESTERN INDIAN OCEAN: Réunion, Bèbour, 22 Mar 1990 J. Boidin (Herb. J. Boidin, ex Herb. Léger 633; det. Léger).

Comments. The type of *H. sphaerospora* is thin (up to 350 μm), whilst most of the new collections are thick or very thick; as in several other species, thickness (or thinness) of basidiomata is a sign of their age and without taxonomical significance until variation of the species is known. The characteristic light rosy grey colour indicated by Léger (1998: 262) is present in fertile specimens with a well-developed basidial layer, but darkens after basidia have collapsed; a similar change of colour has been observed in many species of *Hymenochaete*.

Mean spore size and *Q* value of *H. sphaerospora:*

5.79 x 4.60 μm	1.26	Ethiopia, O 28384
5.89 x 4.49 μm	1.31	Ethiopia, LY 18669
5.91 x 4.58 μm	1.29	Ethiopia, LY 18636
6.17 x 4.80 μm	1.28	Réunion, Herb. Léger 633
6.52 x 5.20 μm	1.25	Réunion, LY, holotype

HYMENOCHAETE TUBERCULOSA Cooke, Grevillea 9: 101 (1881); Massee, J. Linn. Soc. Bot. 25: 112 (1889); Léger, Hymenochaete 280 (1998). Figs. 14, 42

Basidiome effused, adnate, woody hard, more than 10 cm in diam, 1–3 mm thick; hymenium smooth, with a few broad tubercles, deeply cracked, dark brick (M: 2.5 YR 4/4; K & W: 7 E 5, somalis), in middle (fertile) part brownish fawn (M: 2.5 YR 4/3; K & W: 7 E 4, fawn).

Cortex situated above the setal layer, near the substrate and as fragmentary lines in hyphal and setal layers, thick (up to 250 μm), blackish, glossy in section, composed of densely agglutinated brown hyphae; hyphal layer composed of almost loosely interwined hyphae; setal layer thick (up to 1000 μm), stratose.

Hyphal system monomitic; setal hyphae absent; hyphae brown, with thick, sometimes uneven walls, sparsely branched, septate, 3–5 μm diam; setal layers composed of a palissade of cylindrical brownish multiseptate hyphidia 3–5 μm in diam, with submonilioid irregularly thickened (granulose) walls which are thin near the top . Setae numerous, subfusoid, 30–50 x 5–7 μm, acute, sheathed, embedded, some emerging 10–15 μm μm above the hymenium. Basidioles numerous, subhyaline, 15–20 x 4–5 μm, slightly encrusted with granules; basidia cylindrical, (15–)18–22 x 4–5 μm; sterigmata 4, very thin, 1.5–2.5 μm long; spores ellipsoid, one side sometimes slightly flattened, 2.9–4.0 x 1.9–2.5(–2.7).

Known distribution. Brazil: Rio Janeiro, Glaziov 1885 (known only from the type locality).

New locality. Northern South America: Venezuela, Amazonas, Rio Orinoco, Rio Cuao, elev. 125 m, frequent in damp forest, 25 Nov 1948 B. Maguire & L. Politi 27422c (NY).

Comments. The well developed fertile specimen studied fits very well with the description given by Léger (1998), but setae are slightly smaller (Léger: (30–)40–70(–80) x 6–10(–12) μm). However, Massee (1889) indicates setae as 40–60 x 10–12 μm. Léger has seen only some four allantoid spores 4 x 1.5 μm in the type specimen but was not convinced that these belong to this species. The Venezuelan species has numerous spores. The characteristic hyphidia are very similar to those of *H. mollis*; in that species, the setal layers are separated from each other with a distinct hyphal layer. Setae of *H. tuberculosa* have thickened (not very thick) walls which in some cases are almost the same colour as the hyphidia.

Mean spore size and *Q* value of *H. tuberculosa:*

3.45 x 2.16 μm 1.60 Venezuela, NY 27422c

HYMENOCHAETE UNICOLOR Berk. & M.A. Curtis, J. Linn. Soc. Bot. 10: 335 (1868); Léger, Hymenochaete 283, f. 109 (1998). – *H. lignosa* G. Cunn., Trans. R. Soc. New Zeal. 85 (1): 38, f. 22 (1957); Léger, Hymenochaete 179, f. 64 (1998). Figs. 6, 29

Basidiomata effused, adnate, 250–600 μm thick, crustaceous, woody hard; hymenium polygonally cracked, rust or reddish brown (M: 7.5 YR 4.5–5/4–6 or 10 YR 4/4–5; K & W: 6 D–E 6–7); margin distinct.

No tomentum or cortex; thin context (50–100 μm thick) is composed of densely agglutinated hyphae; setal layer distinctly stratose.

Hyphae septate, with thickened or thick walls, 2.5–5(–6) μm diam. Setae numerous, (30–)40–60 x 5–9(–10) μm, emerging 15–40 μm above the hymenium, with acute tip, sometimes ensheathed, some encrusted with small granules. Hyphidia rare or numerous, with thickened walls, some slightly sinuose, brownish, 1.5–3.5 μm diam; basidia subutriform, 15–20 x 4–5 μm, with 4 thin sterigmata; spores ellipsoid, 4.5–5.7 x 2.5–3.3 μm.

Known distribution and hosts. Central Amerca, Caribbean, South America, Eastern Asia, Australasia; found on bark and dead branches of deciduous trees *(Nectandra, Nothofagus* and others).

Types studied. *H. unicolor:* Caribbean, Cuba, C. Wright 541 (K, holotype). *H. lignosa:* see description of it in this paper.

Other specimens studied. Caribbean: Cuba, no. 1376 (K); Cuba, Jan 1915 C.G. Lloyd (K); Cuba, Ekman 9898, det. D.J. Job (S). Australasia: New Zealand, Auckland, Coromandel Peninsula, Whitiange Road, on *Rhopalostylis sapinda,* 24 Oct 1954 J.M. Dingley, det. G. Cunningham, PDD 16624 (K).

New localities. Indo-China: Thailand, Changwat Chiang Mai, Doit Suthep, alt. 1300–1600 m, 18/24 Feb 1979 K. Ryvarden 18024 (O). East Tropical Africa: Tanzania, Tanga Prov., Amboni, Jun 1893 G. Holst (S); Kilimanjaro Prov., Mt. Kilimanjaro S slope, alt. 1800–2300 m, 12 Feb 1973 L. Ryvarden 10354 (O). South Tropical Africa: Kenya, Eastern Prov., Mt. Kenya S slope, alt. 2200–2300 m, 2–3 Feb 1973 L. Ryvarden 9783B (O). NORTHERN SOUTH AMERICA: Venezuela, Parque Nacional Guaramacal, 10 km SW of Batatal, 20-23 Nov 1990 G.J. Samuels *et al.* 7244 (BPI).

Comments. Mean spore size and *Q* value of *H. unicolor:*

5.02 x 2.82 μm	1.78	Tanzania, O 10354

HYMENOCHAETE VALLATA G. Cunn., Trans. R. Soc. New Zeal. 85 (1): 46 (1957); Léger, Hymenochaete 290, f. 113 (1998). Figs. 19, 37

Basidiomata effused, closely adnate, 0.5–2 cm in diam, then confluent and up to 5 cm long, 50–250 μm thick, crustaceous, later minutely cracked. Hymenium umber (M: 5 YR 4/4–5; K & W: 6 E–F 5, teak brown); margin distinctly delimited, concolorous with the hymenium.

Tomentum, cortex and context absent; setal layer composed of crowded setae and adscending agglutinated hyphae, sometimes with numerous large conglomerates of crystals.

Hyphal system subdimitic; generative hyphae brown, with thickened walls, septate, (2–)2.5–3.5 μm diam; skeletoids thick-walled, dark brown. Setae numerous, 25–40(–50) x 4–7(–9) μm, emerging up to 20 μm above the hymenium, narrowly fusoid, thick-walled, with acute tip, sometimes sheathed, not encrusted. Basidioles yellowish, with rough walls, 25–30 x 3–4 μm; basidia subcylindrical, subhyaline, 18–25(–30) x 2.5–3.5 μm; spores cylindrical, slightly curved, 3–4.5 x (1.2–)1.5–2 μm.

Known distribution. AUSTRALASIA: New Zealand, on bark and dead branches. According to Escobar (1978) and Job (1990), also found in Cuba, Venezuela, Brazil and Chile; however, only one Brazilian specimen studied by both Escobar and Job has spores.

Type studied. New Zealand, Auckland, Coromandel Peninsula, on *Coprosma arborea,* 30 Aug 1954 J.M. Dingley PDD 16529 (BPI 279753, isotype).

New localities. INDIAN SUBCONTINENT: India, Tamil Nadu, Tirunelveli Distr., Kalakad Sanctuary, on a fallen twig of an angiosperm tree, 14 Feb 1979 E. Parmasto (TAA 103297). INDO-CHINA: Thailand, Ko Samui, Chaweng Noi, on branch of dead deciduous wood, 15 Feb 2002 F. Dämmrich 6054 (TAA). CARIBBEAN: Virgin Islands (British), Tortola, Sage Mountain, main trail to National Park, 600 m, 6 Oct 2001 P.J. Roberts GA860, 862 (K(M) 121812, 121809). CENTRAL AMERICA: Belize, La Democracia, Birds Without Borders, Nature Trail, 27 Sep 2002 P.J. Roberts B12 (K(M) 106660); Birds Without Borders garden area, 7 Oct 2002 P.J. Roberts B182 (K(M) 106669).

Comments. Mean spore size and *Q* value of *H. vallata:*

3.46 x 1.60 μm	2.16	Belize, K(M) 106660
3.66 x 1.65 μm	2.22	Belize, K(M) 106669
3.71 x 1.80 μm	2.06	India, TAA 103297
4.28 x 1.79 μm	2.39	Virgin Is., K 121809

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Inocutis jamaicensis, the causal agent of eucalypt stem rot in Uruguay

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Abstract—The causal agent of the eucalypt stem rot in Uruguay is determined to be *Inocutis jamaicensis* based on studies of type and representative specimens from different regions. The species is described, illustrated and compared with *Inonotus splitbergeri* and *Phellinus gilvus*, species previously reported to be associated with eucalypt stem rot. Data on hosts and distribution are included.

Key words—*Eucalyptus*, *Hymenochaetaceae*, taxonomy, wood-rot

Introduction

Recently, lesions of variable length and width on the stem of standing trees were observed in plantations of *Eucalyptus globulus* Labill. in Uruguay. The disease occurs mainly in plantations located in SE Uruguay where its incidence ranged between 8 to 15% and also in the western region, but with lower frequency (ca. 5 %) (Martínez et al. 2002).

The typical lesion caused the bark to crack axially and trunk to flatten, exposing the xylem and sometimes forming callused margin lips (Figure 1). A polyporous fungus and a white rotted wood were generally associated with these lesions (Martínez et al. 2002).

The polypore fungus was identified as *Phellinus gilvus* (Schw.) Pat. (Wingfield 1999) at first and later as *Inonotus splitbergeri* (Mont.) Ryvarden (Martínez et al. 2002).

The main goal of this work was to identify and to describe the species associated with stem decay of *E. globulus* from Uruguay, due to its phytopathological importance.

Materials and Methods

Microscopic examination was made from freehand sections mounted in 5% of KOH and 1% phloxine, in Melzer's reagent (IKI) and in 0.5 % cotton blue (CB) in 25 % lactophenol (Singer, 1986). For fruit body identification, morphological characteristics were compared with specimens borrowed from the herbaria ENCB, FLOR, ICN, MVHC and NY (Holmgren et al., 1990) and from Centro de Investigación y Extensión Forestal Andino Patagónico, CIEFAP (Esquel, Argentina).

Taxonomic Description

Inocutis jamaicensis (Murrill) Gottlieb, J.E. Wright & Moncalvo, Mycological Progress 1:308, 2002 (August). **Figure 2, 3.**
= *Inonotus jamaicensis* Murrill, Bull. Torr. Bot. Cl. 31:597, 1904. (NYBG!)
= *Inocutis jamaicensis* (Murrill) T. Wagner & M. Fischer, Mycologia 94: 1011, 2002 (December).

Basidiocarps annual, first nodulose, then effuse-reflexed to pileate, sessile, dimidiate, applanate to mostly triquetrous in section, imbricate or occasionally single, 2–4 x 3–7 x 0.5–1.5 cm. Upper surface first yellow brown and rugose, finely tomentose and slightly zonate, then becoming blackish with a thin crust and slightly zonate. Pore surface first creamy brown, then dark brown with grayish parts, pores 3–5(–6) per mm, circular to angular, slightly larger near the border. Tubes concolorous or lighter in color than context in old specimens, up to 2 cm deep. Context thin, up to 5 mm thick, slightly zonate, golden brown to dark cinnamon or rusty brown, separated or not with black lines from tomentum. In some specimens black lines distributes over older parts of the context. Tomentum present or not in young parts, when present golden brown, slightly zonate and more fibrous than context. **Hyphal system** monomitic, generative hyphae with simple septa, yellowish to rusty brown or reddish brown in old specimens, thin to thick walled, 2–7 μm wide. Contextual hyphae with simple septa, yellow brown to dark reddish brown 4–10 μm wide, thick walled, with a wide lumen. Hyphae from tomentum, when present, similar to contextual hyphae but lighter in color, golden to reddish yellow. Setal hyphae absent. Setae absent. Basidia subclavate, 4-sterigmate, hyaline, 12–18 x 5–6 μm. Basidiospores very abundant in most specimens, ellipsoid, thick-walled and with a straight side, rusty to umber or reddish brown, guttulate, 5,5–7,0 (–7,5) x 4–5 μm, IKI–, CB– **Associated decay** white rot.

Substrates. Recorded on dead and living hardwoods, such as *Allophyllus, Cedrela, Celtis, Diostea, Duranta, Eucalyptus, Fraxinus, Lomatia, Phylica, Prunus, Quercus* (Gilbertson & Ryvarden 1987; Gottlieb et al. 2002; Pegler 1964; Rajchenberg & Wright 1998), *Acacia* and *Eupatorium.*

Distribution. Known from Argentina (Rajchenberg & Wright 1998; Gottlieb et al. 2002), Brazil (Rajchenberg 1987; Rajchenberg & de Meijer 1990), Chile (L. Ryvarden, pers. comm.), Arizona, U.S.A. (Gilbertson & Ryvarden 1987), Jamaica (Holotype), México, Tristan da Cunha (Pegler, 1964) and Uruguay (Gottlieb et al., 2002).

REPRESENTATIVE SPECIMENS EXAMINED: *Inocutis jamaicensis*– **ARGENTINA. BUENOS AIRES:** Magdalena, Estancia 'El Destino', 28 Aug. 1984, *leg. M. Rajchenberg & D. Job, det. J. E. Wright* (MVHC exBAFC). **CHUBUT:** P. N. Lago Puelo, *ca* Arroyo Los Tineos, 10 May 1996, on dead *Diostea juncea, leg. & det. M. Rajchenberg* (MVHC exCiefap). P.N. Los Alerces, Lago Verde, sendero a Lago Menéndez, 6 May 1996, on fallen trunk of *Lomatia hirsuta, leg. & det. M. Rajchenberg 11116* (MVHC exCiefap). **CÓRDOBA:** Cuesta Blanca, 10 Jul. 1999, on *Eupatorium tuneifolium, leg. C. Urcelay 132, det. M .Rajchenberg* (MVHC exCORD). **JAMAICA.** Mabess River, 3000 ft., *L. M. Underwood*, 23 Apr. 1903, *Inonotus jamaicensis*, (**Holotype**-NYBG). **URUGUAY. CERRO LARGO:** Bañados de Medina, 31 Aug. 1973, on *Eucalyptus* sp., *leg. L. Bettucci* (MVHC302). **FLORIDA:** Santa Margarita, Aug. 2002, on *E. globulus, leg. R.*

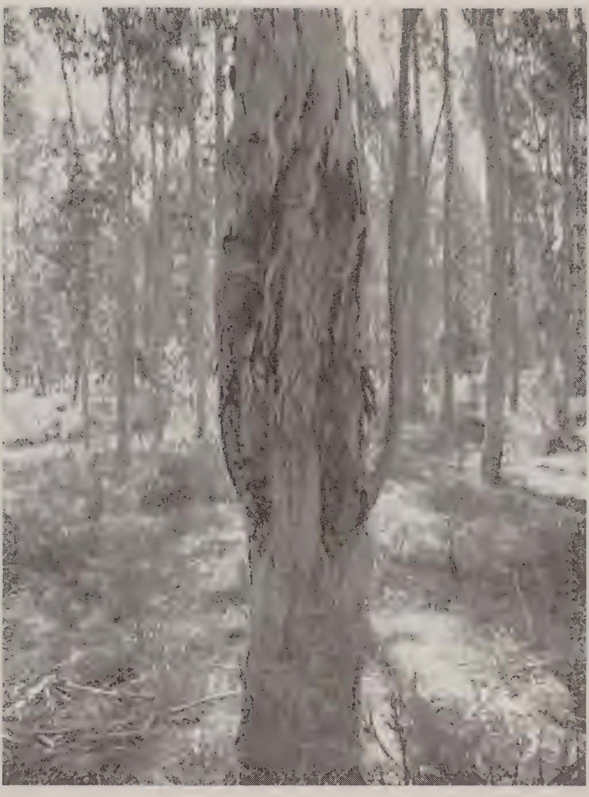

FIGURE 1. Standing *Eucalyptus globulus* with damaged bark and trunk deformations caused by *Inocutis jamaicensis.*

Linares (MVHC5057, 5058). Route 7, Est. 'Piedra Cabeza', Aug. 2002, on *E. globulus, leg. R. Linares* (MVHC5059). **LAVALLEJA:** Paraje Higueritas, 20 Oct. 2002, on dead *Eupatorium buniifolium, leg. G. Pérez* (MVHC5273, 5274). Carapé, 3 Set. 2003, on *E. globulus, leg. S. Lupo, S. Simeto, L. Bettucci & S. Martínez* (MVHC5229, 5230, 5231, 5232, 5233). **MALDONADO:** Laguna Blanca, 25 Aug. 2003, on *Acacia* sp., *leg G. Pérez* (MVHC5280). José Ignacio, Laguna Escondida, 25 Aug. 2003, on *Acacia* sp., *leg G. Pérez* (MVHC5281). Manantiales, Laguna Blanca, 25 Aug. 2003, on *Acacia* sp., *leg. G. Pérez* (MVHC5282, 5283). **PAYSANDÚ:** Algorta, Estab. 'Santo Tomás', 15 Oct. 2002, on standing *E. globulus, leg. S. Martínez* (MVHC5108). Pandule, Estab. 'El Cerro', 12 Sep. 2003, on standing *E. globulus, leg. F. Rivas, G. Pérez & S. Martínez* (MVHC5275, 5276). **RÍO NEGRO:** Tres Bocas, Est. 'La Nona', 20 Aug. 2002, on *E. globulus, leg. G. Pérez, F. Rivas & S. Martínez* (MVHC5064, 5065). **TACUAREMBÓ:** Frigorífico Tacuarembó, Leñera 2, 4 Jul. 1992, on *E. grandis, leg. L. Bettucci, N. Telechea, M. Speranza & L. Fernández* (MVHC743). **U.S.A. ARIZONA:** Cochise Co., South Fork of Cave Creek, Chiricahua Mts., Coronado National Forest, 1 Sep. 1985, on *Quercus arizonica, leg. &*

det. R. L. Gilbertson 15819 (Ciefap). ***Inonotus splitbergeri*– BRASIL. RÍO GRANDE DO SUL:** Santa María, Camobi, 25 May 1993, *leg. & det. R. Coelho 39-1* (ICN97683). Santa María, final Rua Lancheria Timbaúva, 18 Feb. 1992, *leg. & det. G. Coelho 11-4* (ICN97682). Porto Alegre, Belém Novo, 1993, *leg. M. S. Hamme, det. G. Coelho* (ICN97686). **MÉXICO. VERACRUZ:** NE de Cosoleacaque, road Minatitlán-Acayucán, 21 Aug. 1976, alt. 40 m, *det. R. Valenzuela, leg. J. Pérez-Ortiz 304* (MVHC5154, ENCB). El Mirador, Municipio de Totutla, 29 Nov. 1972, 1000 m, on dead trunks of 'encino' (*Quercus* sp.?), *det. R. Valenzuela, leg. F. Ventura 7510* (FLOR12017).

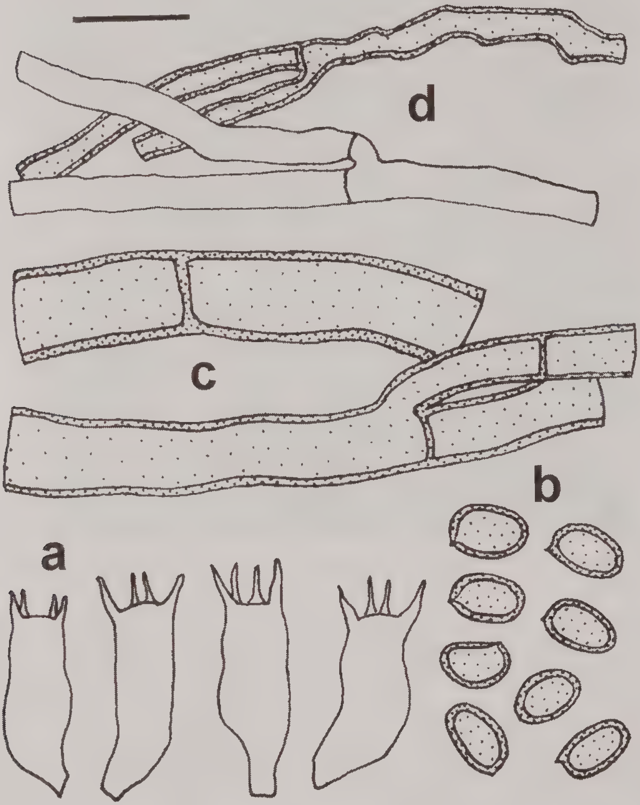

FIGURE 2. Microscopic characters of *Inocutis jamaicensis*. a. basidia; b. basidiospores; c. contextual hyphae; d. tramal hyphae. Bar = 10 μm.

Comments—For additional descriptions and illustrations of *I. jamaicensis*, see Gilbertson & Ryvarden (1987), Gottlieb et al. (2002), Pegler (1964) and Rajchenberg & Wright (1998).

Gottlieb et al. (2002) also provide an extensive synonymy of *I. jamaicensis*.

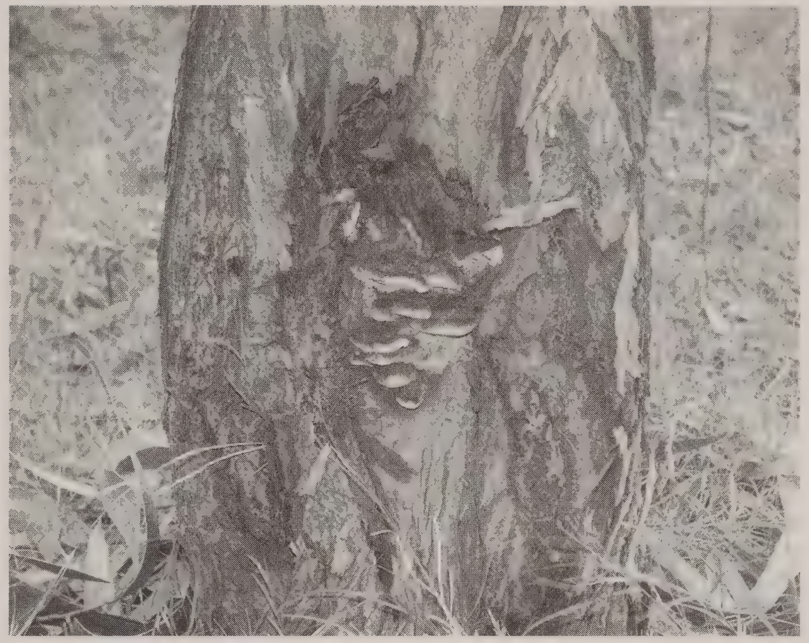

FIGURE 3. Basidiocarps of *Inocutis jamaicensis* in a standing *Eucalyptus globulus*.

Discussion

A careful comparative study of *Inocutis jamaicensis, Phellinus gilvus* and *Inonotus splitbergeri* demonstrates that *I. jamaicensis* is the causal agent of one of the most important stem rots affecting *Eucalyptus globulus,* and to a lesser extent *Eucalyptus maidenii* F. Mueller and *Eucalyptus grandis* W.Hill: Maiden (pers. obs.). It is pileate, triquetrous and brownish, with a monomitic hyphal system, lacking setae, and brownish, thick-walled basidiospores. Conversely, *P. gilvus* has a dimitic hyphal system, hymenial setae, and hyaline, thin-walled spores (Gilbertson & Ryvarden 1987). Characteristics that do not correspond to the species associated with the stem rot.

Microscopically, *I. splitbergeri* shares with *I. jamaicensis* a monomitic hyphal system and similar thick-walled and pigmented spores. Specimens of *I. splitbergeri* from Brazil and Mexico are characterized by lemon yellow basidiocarps that are thinner and develop smaller pores (5–8/mm) than those of *I. jamaicensis*. In addition, the context and pileus of *I. splitbergeri* turn red in 5% KOH, a reaction not found in *I. jamaicensis*.

The symptoms related to *I. jamaicensis* are not specific and, thus, cannot be used to diagnose an infection before the formation of fruit bodies. In vitro cultures of the fungus or from decayed wood are extremely similar to other species of poroid *Hymenochaetaceae,* making identification from cultures very difficult (Rajchenberg & Wright 1997).

Inocutis jamaicensis was first recorded from Uruguay by Gottlieb et al. (2002). Although, it was not associated with the stem rot of eucalypts. On the other hand, they cited a specimen collected by Spegazzini in 1914 suggesting that *I. jamaicensis* was present in Uruguay since the early twentieth century. They also recorded this species on *E. viminalis* Labill. in Argentina, but without any mention of an associated stem rot decay. The Uruguayan specimens fit the descriptions given by different authors (Gottlieb et al. 2002; Rajchenberg & Wright 1997; Gilbertson & Ryvarden 1987). However, the Uruguayan specimens have a more robust basidiocarp and pileate habit.

Inocutis jamaicensis is related to a major group within *Inonotus* P.Karst. *s.l.* that comprises species belonging to the *Inonotus rheades* (Pers.) Bondartsev & Singer group (Gottlieb et al. 2002; Wagner & Fischer 2002). This group was recognized previously as the genus *Inocutis* Fiasson & Niemelä (Fiasson & Niemelä 1984), differing from *Inonotus s.s.* by the absence of setae and the presence of a marmorate core. *Inocutis* was recognized as a well supported group within *Inonotus s.l.* by phylogenetic analysis of sequences from Internal Transcribed Spacer (ITS) and nuclear Large Sub-Unit (LSU) ribosomal DNA regions (Wagner & Fischer 2001, 2002; Gottlieb et al.,2002). *I. jamaicensis* differs from other species of *Inocutis* by the absence of a granular core. Recently Wagner & Fischer (2002) transferred *Xanthochrous ludovicianus* Pat., along with *I. jamaicensis*, to the genus *Inocutis* based on sequences of the nuclear LSU. Previously Gottlieb et al. (2002) transferred *I. jamaicensis* to the same genus based on sequences of the nuclear ITS region.

Inocutis rheades (Pers.) Fiasson & Niemelä (as *Inonotus rheades*) was reported to produce similar symptoms and a stem white rot in *E. saligna* Smith plantations in Porto Alegre, in southern Brazil (De Castro & Krügner, 1984). The species is probably *I. jamaicensis* since *I. rheades* has been only found in the northern hemisphere and mostly on *Populus* spp. and rarely on other substrata such as *Quercus* spp. and *Fraxinus* spp. (Gilbertson & Ryvarden, 1986).

Inocutis jamaicensis is known from southern Brazil since the early twenty century when it was invalidly recorded as *Polyporus hispidus* Bull.:Fr. var. *minor* Rick (Rajchenberg 1987).

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New and noteworthy polypores from Poland with validation of the family *Phaeotrametaceae*

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Abstract – The following four polypores are described, illustrated and discussed: *Anomoporia kamtschatica* and *Skeletocutis biguttulata* are new for Poland, while *Inonotus nidus-pici* and *Skeletocutis kuehneri* are confirmed in the country. *Skeletocutis subincarnata* is removed from the list of mycota from Poland. The family *Phaeotrametaceae* is validated.

Key words – Basidiomycetes, wood-rotting fungi, Europe

Introduction

Although polypores of Poland are relatively well known from the monographs of Domański (1965) and Domański et al. (1967), numerous recent taxonomic studies have made further research on this group of fungi necessary. Recent papers by the first author have added new species to the Polish mycota (Piątek 2001, 2003a-b) and established further information on the occurrence of many rarities (Piątek 1999, 2000a-b, 2002a-e, 2003c, 2004, Piątek & Cabała 2002). During ongoing polypore studies, we examined collections from KRAM and KRAM-Domański, and discovered four species rarely collected in Europe. Two are new to Poland and two are confirmed for the country.

Taxonomic description

Anomoporia kamtschatica (Parmasto) Bondartseva **FIGURE 1**
Novosti Sist. Nizsh. Rast. 9: 135. 1972.

Basidiomes annual, resupinate, widely effused, soft and friable in both fresh and dry conditions, appearing as small round patches, up to 2 cm in diameter, margin cottony, white, non-rhizomorphic; pore surface cream-white, pores regular or irregular, 2–3 per mm; hyphal system monomitic, generative hyphae with clamps, branched, loosely intermixed, up to 4.5 μm wide; basidia clavate or almost cylindrical, 4-sterigmate, with

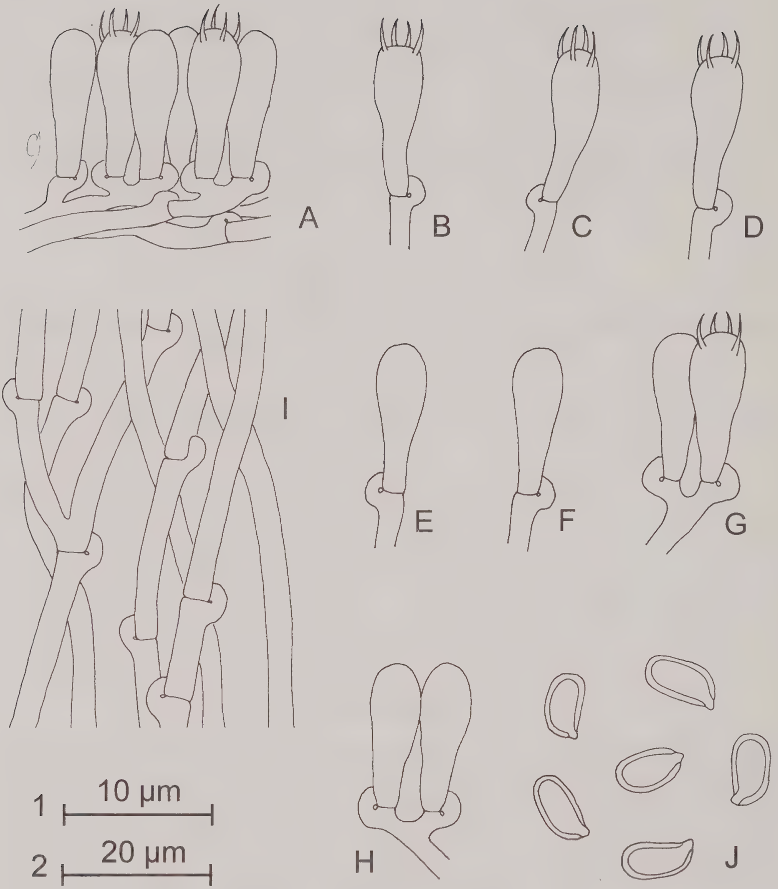

Fig. 1. *Anomoporia kamtschatica*: A – hymenium, B–H – basidia, I – hyphae, J – basidiospores. Scale bars: 1 for J, 2 for A–I.

basal clamp, 11.0–20.0 × 4.0–6.5 *µ*m; basidiospores ellipsoid, thick-walled, hyaline, smooth, with small apiculus at the adaxial side, usually with one drop, 3.9–5.1 × 2.9–3.7 *µ*m.

SPECIMEN EXAMINED—Poland. Wyżyna Śląsko-Krakowska: Puszcza Dulowska near Trzebinia, on fallen branch of *Pinus sylvestris*, 23.IX.1966, *S. Domański* (KRAM-Domański 5181).

COMMENTS – *Anomoporia kamtschatica* is characterized by a thin, cottony margin, and thick-walled, cyanophilous basidiospores. It appears rather similar to *A. myceliosa* (Peck) Pouzar but the latter differs inter al. in its rhizomorphic margin and smaller, thin-walled basidiospores.

Anomoporia kamtschatica was first described from Russian Far East by Parmasto (1963), and was for a long time known only from this locality until Niemelä (1994) found that it is widely distributed but scattered in North America and Europe, where it was misidentified as *A. myceliosa*. The Polish specimen was also originally determined by Stanisław Domański as *Fibuloporia myceliosa* (Peck) Domański, but this identification was accompanied by a question mark, and probably for this reason the record was never published. *Anomoporia ambigua* A. David & Gilles described from France is a later, heterotypic synonym of *A. kamtschatica* (see Niemelä 1994).

In Europe it is still rarely reported. Previously known from the Czech Republic, Finland, France, Germany, Norway, Sweden, and European part of Russia (Niemelä 1994, Niemelä et al. 2001, Ryvarden et al. 2003), the species now adds Poland to its general distribution.

Inonotus nidus-pici Pilát **FIGURE 2**

Acta Mus. Nat. Pragae IX, B, No. 2, Bot. 1: 108. 1953.

Basidiomes annual, resupinate, effused, brittle in dry condition, loosening from the substrate; pore surface brown when dry, pores circular, 5–6 per mm; imperfect basidiomes predominate in the collection, annual to biennial, hard, spherical to oblong, up to 6 cm long, yellowish brown when young to black when old, and then covered by chlamydospores, inner part brown; hyphal system monomitic, generative hyphae simple-septate, thick-walled, yellow to brown, richly branched, up to 5 μm wide; hyphoid setae abundant, both in sterile and imperfect basidiomes, dark brown, 100–300 × 5–15 μm; hymenial setae rare, dark brown, fusiform, 10–50 × 7–9 μm; basidia clavate, simple-septate at the base, 15–20 × 6–7 μm, sterigmata not seen; basidiospores not seen; chlamydospores abundant, variously shaped, thick-walled, olive-brown, 1–4-celled, 5–20 × 3–5 μm.

SPECIMEN EXAMINED — POLAND. POJEZIERZA POŁUDNIOWOBAŁTYCKIE: Łagów Lubuski near Świebodzin, in hollow on living trunk of *Fagus sylvatica*, 23.VIII.1974, *S. Domański* (KRAM-Domański 7197).

COMMENTS – *Inonotus nidus-pici* is easily distinguished by its production of chlamydospores and occurrence in cavities on trunks of living trees, mostly *Quercus* and (rarely) other hardwoods. The only other European *Inonotus* that forms chlamydospores, *I. rickii* (Pat.) D.A. Reid, is an extremely rare Mediterranean species, reported from Greece, Italy, Montenegro, and Spain (Ryvarden & Gilbertson 1993, Kotlaba & Pouzar 1994, Intini 2002, Annesi et al. 2003).

Inonotus nidus-pici is a rare European species, distributed from Spain and France in the west through Central Europe to countries bordering the Black Sea in the east. On their map Ryvarden and Gilbertson (1993) show the species from Poland, but the source of their information is unknown. The 1974 collection reported in this paper is the first fully documented record of *I. nidus-pici* from Poland. The collection was discovered in the herbarium of the late Prof. Stanisław Domański, now preserved in KRAM. It is difficult to know why he did not publish this record, since it was clear that it represented a species new to Poland whose identification was firm.

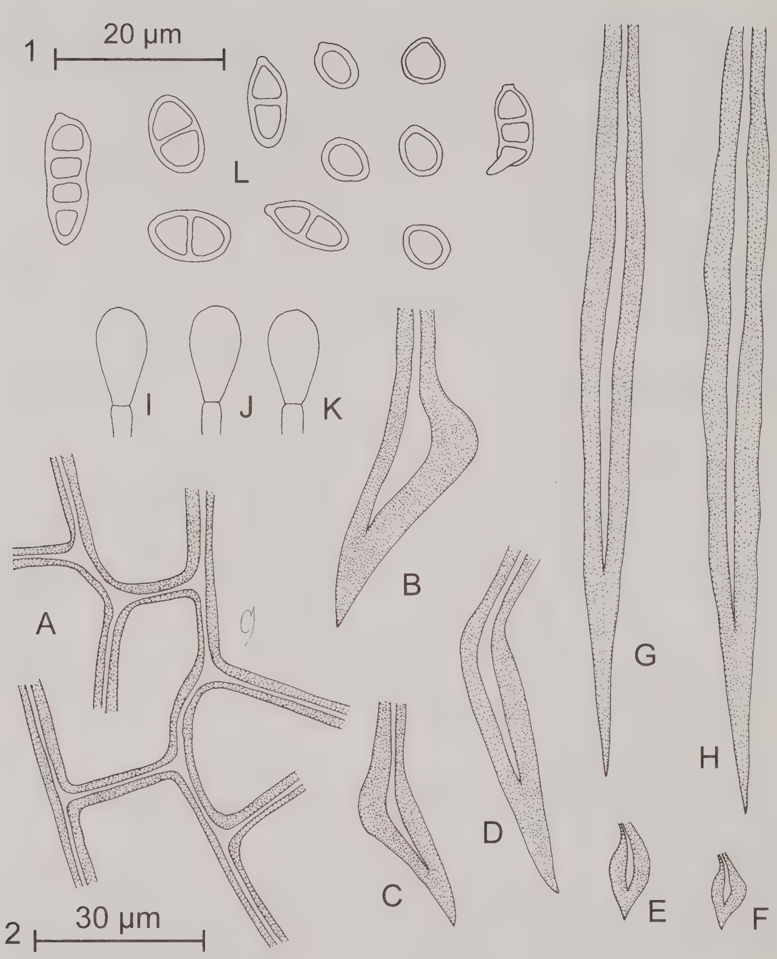

Fig. 2. *Inonotus nidus-pici*: A – hyphae, B–F – hymenial setae, G–H – hyphoid setae, I–K – basidia, L – chlamydospores. Scale bars: 1 for L, 2 for A–K.

Skeletocutis biguttulata (Romell) Niemelä **FIGURE 3**
Acta Bot. Fennica 161: 5. 1998.

Basidiomes annual, resupinate, widely effused, making up ellipsoid patches, up to 20 cm long and 5 cm wide, or sometimes larger, rather hard and usually cracked in dry condition, margin sterile, narrow, finely radiate; pore surface creamy, light ochraceous and sometimes with pinkish tint, pore rather regular, 5–7 per mm; hyphal system dimitic, generative hyphae thin-walled, with clamps, moderately branched, up to 2.5 µm wide, heavily encrusted at the dissepiments edges, skeletal hyphae thick-walled, non-septate, up to 4 µm wide; cystidia absent, but fusoid cystidioles usually present, 10–15 × 3–5 µm; basidia clavate, 4-sterigmate, with basal clamp, 10–15 × 4–7 µm; basidiospores allantoid, slightly curved at the adaxial side, hyaline, non-amyloid, with two distinct, darker guttules at the each end, 4.5–6.0 × 1.2–1.5 µm.

SPECIMENS EXAMINED (SELECTED) — **POLAND. WYSOCZYZNY PODLASKO-BIAŁORUSKIE:** Puszcza Białowieska, on fallen trunk of *Picea abies*, VII.1958, *S. Domański* (KRAM-Domański 3000), same location, on fallen trunk of *Pinus sylvestris*, 23.IX.1965, *S. Domański* (KRAM-Domański 4871), same location and host, 28.X.1956, *S. Domański* (KRAM-Domański 697), same location, on fallen trunk of *Picea abies*, 8.VI.1960, *S. Domański* (KRAM-Domański 2994); **POJEZIERZA WSCHODNIOBAŁTYCKIE:** Kamień near Mrągowo, on fallen trunk of *Pinus sylvestris*, 17.VI.1958, *S. Domański* (KRAM-Domański 3003), same location, on fallen trunk of *Picea abies*, 23.VIII.1956, *S. Domański* (KRAM-Domański 2997); Ruciane-Przystań near Mrągowo, on fallen trunk of *Pinus sylvestris*, 19.VI.1958, *S. Domański* (KRAM-Domański 2996); Kowalik near Ruciane, on fallen trunk of *Pinus sylvestris*, 27.VIII.1957, *S. Domański* (KRAM-Domański 820); Wierzba near Ruciane, on roots of fallen trunk of *Pinus sylvestris*, 24.VIII.1957, *S. Domański* (KRAM-Domański 821); **WESTERN CARPATHIANS: Beskid Niski Mts**, Wapienne near Gorlice, on fallen trunk of *Abies alba* and leaf of *Fagus sylvatica*, 23.VIII.1963, *S. Domański* (KRAM-Domański 3327).

COMMENTS – *Skeletocutis biguttulata* was only recently resurrected from oblivion by Niemelä (1998), who also re-described and illustrated it. Previously the collections of this species were assigned to *S. subincarnata* (Peck) Jean Keller, and, in fact, the two are closely related taxa. *S. biguttulata* is separated from the latter by its biguttulate spores and more regular pores with cracking pore surface in old specimens.

In Poland, the fungus known as *Skeletocutis subincarnata* was published several times in the literature. From the end of 19th century and beginning of 20th century there are numerous records of *Polyporus vulgaris* Fr., which may belong to this species complex, but they cannot be verified because no voucher specimens are preserved. The first reliable records are from late 1950s and early 1960s (Domański 1963, 1965). Later, the species was found only occasionally (Kotlaba & Lazebníček 1967, Anonymous 1968, Wojewoda 1998).

In the available herbaria we located and examined only Domański collections and found that all specimens determined by him as *Poria vulgaris* (Fr.) Cooke or *Incrustoporia subincarnata* (Peck) Domański possess basidiospores with striking guttules at the each end. We consider all Domański collections to represent *Skeletocutis biguttulata.* Despite the relatively high number of specimens (in total 27 specimens examined), all were collected from only three areas: Puszcza Białowieska and neighbouring of Ruciane-Nida in Puszcza Piska in northeastern Poland and the Beskid Niski Mts in the Carpathians. Hosts were *Pinus sylvestris* (14 collections), *Picea abies* (12 collections), *Abies alba* and leaf of *Fagus sylvatica* (1 collection). This is in accordance with observations by Niemelä (1998), who mentioned *Pinus sylvestris* as the main host for *S. biguttulata*. The earliest Polish collections of this polypore were made in May and the latest in October. Most records originate from August, but many specimens were also collected in June and September.

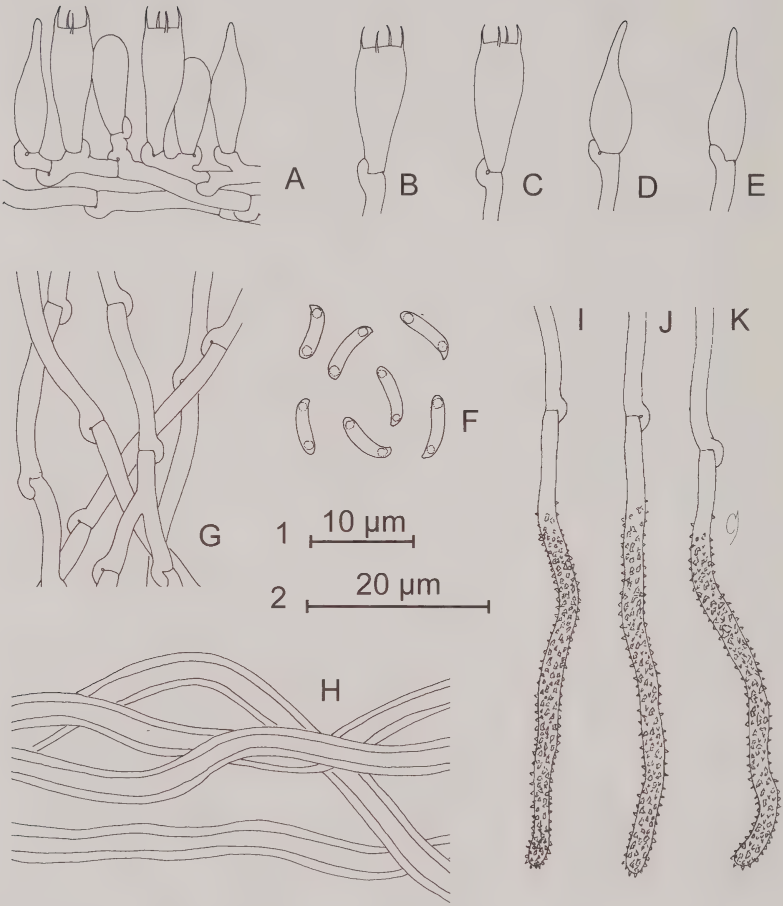

Fig. 3. *Skeletocutis biguttulata*: A – hymenium, B–C – basidia, D–E – cystidioles, F – basidiospores, G – generative hyphae, H – skeletal hyphae, I–K – encrusted hyphal ends. Scale bars: 1 for F, 2 for A–E and G–K.

Skeletocutis biguttulata is not well known in Europe, and its exact distribution cannot be established without re-evaluating *'Skeletocutis subincarnata'* herbarium collections. Thus far, *S. biguttulata* has been reported from Fennoscandia (Finland, Norway, Sweden, see Niemelä 1998, Ryvarden et al. 2003) and Estonia, France and Russia (Niemelä 1998, Niemelä et al. 2001). *S. subincarnata* s. str. should probably be eliminated from the Polish mycota.

Skeletocutis kuehneri A. David **FIGURE 4**
Naturaliste Canad. 109: 248. 1982.

Basidiomes annual, resupinate, widely effused, up to 5 cm long and 4 cm wide, waxy when fresh, brittle in dry condition, margin very narrow, finely radiate, white; pore surface white when fresh, pale yellow when dry, pores angular 4–5 per mm; hyphal system dimitic, generative hyphae thin-walled, with clamps, moderately branched, up to 3 μm wide, encrusted in the dissepiments, skeletal hyphae thick-walled, non-septate, up to 4 μm wide; cystidioles fusoid, with basal clamp, 8–12 × 3–4 μm; basidia clavate, 4-sterigmate, with basal clamp, 8–15 × 4–5 μm; basidiospores narrowly allantoid, slightly curved, hyaline, non-amyloid, 3.0–4.0 × 0.7–1.0 μm.

> **SPECIMENS EXAMINED — POLAND. WESTERN CARPATHIANS: Pogórze Rożnowskie**, between Wola Stróska and Borowa, on slope of Mogiła Mt., on dead basidiome of *Trichaptum abietinum* growing on fallen branch of *Abies alba*, 9.VIII.1999, *M. Piątek* (KRAM F-39777); **Pogórze Ciężkowickie,** Ryglice, near Galia Górna farmstead, on fallen trunk of *Abies alba*, close dead basidiomes of *Trichaptum abietinum*, 8.VIII.2000, *M. Piątek* (KRAM F-53805).

COMMENTS – *Skeletocutis kuehneri* is characterized by pale yellow basidiomes in dry condition, narrowly allantoid basidiospores and association with dead basidiomes of *Trichaptum* Murrill. Another species linked with decaying specimens of *Trichaptum* is *S. carneogrisea* A. David, which has effused-reflexed basidiocarps and wider basidiospores. *S. chrysella* Niemelä has similar yellowish basidiomes but, unlike *S. kuehneri*, is associated with old specimens of *Phellinus chrysoloma* (Fr.) Donk.

Skeletocutis kuehneri is somewhat uncommon, reported from Western and Central Europe (Czech Republic, France, Germany, Great Britain, Holland, Italy; Ryvarden & Gilbertson 1994, Vampola & Pouzar 1996, Bernicchia 2001, Cooper 2004), Fennoscandia (Finland, Norway, Sweden, see Ryvarden & Gilbertson 1994, Niemelä 1998, Ryvarden et al. 2003), and NW Russia (Niemelä et al. 2001). The map in Ryvarden and Gilbertson (1994) places the species also in Poland but the authors do not cite either literature or herbarium references. The two Western Carpathian sites noted above represent the first documented collections of *S. kuehneri* for Poland. In this country, the species has been recorded on wood of *Abies alba,* a host previously noted in Italy (Bernicchia 2001). *S. kuehneri* is more often reported from *Picea*, *Pinus* and *Larix*. Outside Europe, the species has been reported from China, Japan and Far East of Russia (Núñez & Ryvarden 2001).

Validation of the family *Phaeotrametaceae*

Phaeotrametes is a remarkable genus, characterized by brownish, trametoid basidiomes, trimitic hyphal system, truncate, large, thick-walled, non-amyloid and non-cyanophilous basidiospores and occurrence of chlamydosporic fruit-bodies next to normal basidiomes. Its truncate, thick-walled basidiospores make it somewhat similar to *Perenniporia* Murrill, but the spores of this latter genus are usually smaller and the species do not produce characteristic chlamydosporic fruit-bodies. *Loweoporus* J.E.

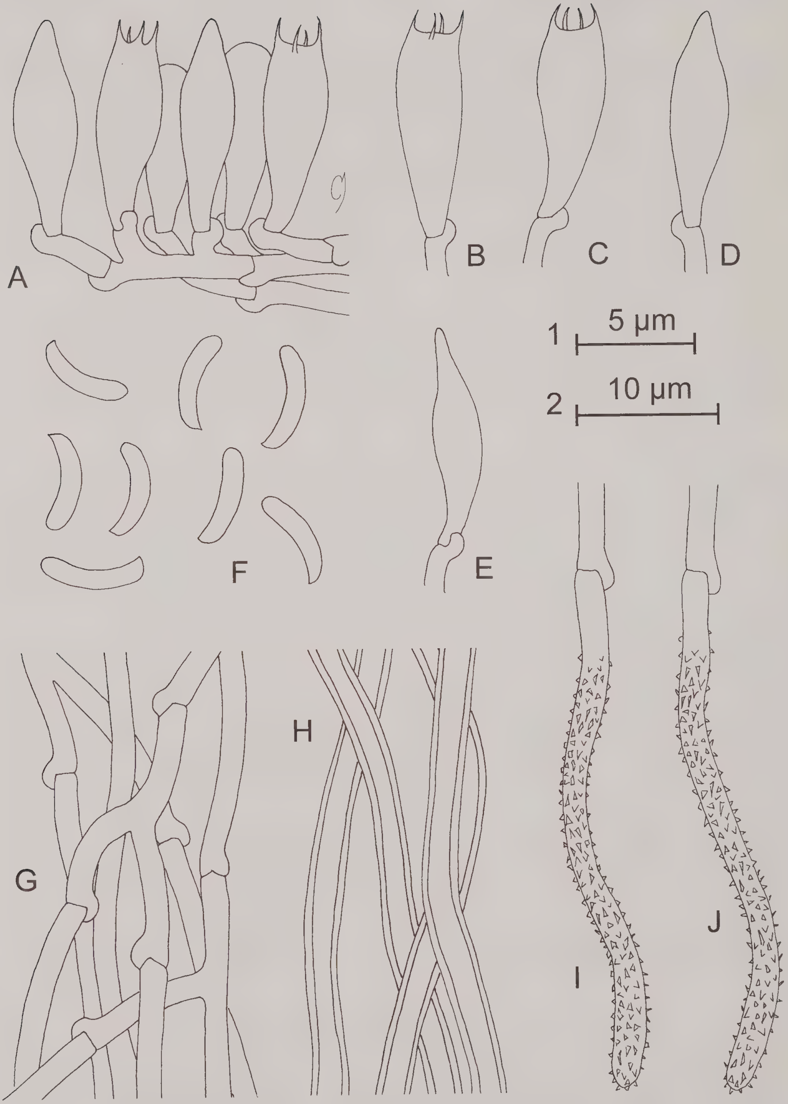
A
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Fig. 4. *Skeletocutis kuehneri*: A – hymenium, B–C – basidia, D–E – cystidioles, F – basidiospores, G – generative hyphae, H – skeletal hyphae, I–J – encrusted hyphal ends. Scale bars: 1 for F, 2 for A–E and G–J.

Wright and *Pyrofomes* Kotl. & Pouzar also have similarly shaped spores but they are smaller than in *Phaeotrametes*. Moreover, the basidiomes in the two former genera are grey, brown to fuscous and reddish, respectively, and they do not form chlamydosporic fruit-bodies. Lloyd (1915) introduced the name *Phaeotrametes* but, because it was invalidly published, Wright (1966) validated the name, together with extensive description and discussion of its only species *P. decipiens* (Berk.) J.E. Wright, which is widely distributed in the Southern Hemisphere. In some papers (e.g., Ryvarden 1991, Popoff 2003) the authority for the genus *Phaeotrametes* is attributed to Wright alone as *Phaeotrametes* J.E. Wright, but full author citation should be *Phaeotrametes* Lloyd *ex* J.E. Wright, and such entry is given in the latest edition of the 'Dictionary of the fungi' (Kirk et al. 2001).

Popoff (2003) introduced a new family name *Phaeotrametaceae* Popoff to accommodate this highly isolated genus. His decision is sound and well supported. However, he did not give Latin description for this new family, and hence his name is invalid. Therefore, the name *Phaeotrametaceae* is validated here.

Phaeotrametaceae Popoff *ex* M. Piątek, *fam. nov.*
Phaeotrametaceae Popoff, Mycotaxon 87: 106. 2003, *nom. inval.*

> *Basidiomata supralignea, effuso-reflexa vel resupinata, trametoidalia. Systema hypharum trimiticum. Basidiosporae ellipsoideae, truncatae, crassitunicatae, non amyloideae, non cyanophilicae. Fructificationes chlamydosporicae plerumque iuxta basidiomata normalia sunt. – Typus: Phaeotrametes* Lloyd *ex* J.E. Wright.

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A new species of *Dactylella* and its teleomorph

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Abstract— *Dactylella lignatilis*, a new species, is described as the anamorph of an unidentified species of the genus *Hyalorbilia*. The fungus produces spindle-shaped to cylindrical conidia with 1-6 septa (usually 3-4). The conidia are 25-51 μm long ($\bar{x}$=41), 2.5-6.3 μm wide ($\bar{x}$=4.8), and are solitarily borne on extensively ramified conidiophores. The fungus fails to trap nematodes on water agar medium when challenged with nematodes.

Keywords—anamorph-teleomorph connection

Introduction

The fungi of *Orbiliaceae* Nannf. show cup-shaped ascomata and usually occur in nature on substrates that are either continually moist or periodically dry out. Traditionally, the *Orbiliaceae* was placed within the *Helotiales* Nannf. and originally included three genera, *Orbilia* Fr., *Hyalinia* Boud. and *Patinella* Sacc. (Nannfeldt 1932). However, in the opinion of Spooner (1987), *Patinella* was to be misplaced in *Orbiliaceae* and the genus *Habrostictis* Fuckel should be included in the family. Furthermore, a critical analysis of the combination of morphological characters showed that *Habrostictis* and *Hyalinia* were synonymized with *Orbilia* (Baral 1994). Molecular evidence proved that the *Orbiliaceae* are not closely related to the *Helotiales* and now only two genera, *Orbilia* and *Hyalorbilia* Baral & G. Marson, were accepted for which a new class Orbiliomycetes was created (Eriksson et al. 2003). Many fungi have life cycles that include both sexual states (teleomorphs) and asexual states (anamorphs), and these may legitimately be given separate names (Hennebert & Weresub 1977, Weresub & Hennebert 1979). The known anamorphs of *Orbilia* include both predacious and non-predacious fungi. The predacious forms fall into the genera *Arthrobotrys* Corda (Pfister 1994, Pfister & Liftik 1995) and *Monacrosporium* Oudem. (Rubner 1996, Liu et al. 2002). Apparently non-predacious anamorphs of *Orbilia* include *Anguillospora* Ingold (Webster & Descals 1979, Pfister 1997), *Dactylella* Grove (Thakur & Zachariah 1989; Webster et al. 1998), *Dicranidion* Harkn. (Berthet 1964, Korf 1992), *Dwayaangam* Subram. (Kohlmeyer et al. 1998), *Helicoon* Morgan (Pfister 1997), cf. *Idriella* P.E. Nelson & S. Wilh. (Haines & Egger 1982) and *Trinacrium* Riess. (Matsushima 1995). Here we report a new anamorph associated with an unidentified species of *Hyalorbilia*.

Materials and methods

While surveying orbiliaceous fungi, several apothecia of the genus *Hyalorbilia* on the periderm of *Pinus* sp. were collected from Xiaobailong Mountain, Kunming City, Yunnan Province, P. R. China on 10 Sep 2003. To isolate its anamorph, the apothecia were attached to the lid of a Petri-dish (diam=90 mm) using medicated Vaseline. The lid was placed over the base of the dish which contained 2% corn meal agar medium (CMA). The dishes were arranged so that the ascospores were projected upwards towards the light and were deposited on the CMA above. Ascospores projected on the agar after 2- 4 days and the blocks with germinating ascospores were transferred onto CMA slants and cultured at 28°C. Finally, the apothecia whose ascospores partly projected were examined and identified. To identify the anamorph, the cultures in slants were inoculated on CMA plates. After 60 days at 28°C, the taxonomic characters were examined and measured. The sizes of conidia and conidiophores were obtained after randomly measured 100 conidia and 20 conidiophores. To induce trap formation, the cultures were inoculated on 12 plates which containing water agar medium (WA), and for each plate, about 100 nematodes (*Panagrellus redivivus*) were added after incubation of 60 days at 28°C. The potential of trap formation was determined after incubation for further10 days at 20°C, 25°C and 28°C respectively. The micrographs were taken using an Olympus BX51 microscope.

Taxonomic Description

Anamorph: *Dactylella lignatilis* M.H. Mo & K.Q. Zhang, sp. nov. FIGURES 1-2

Mycelium effusum. Hyphis sterilibus hyalinis, septatis, ramosis, plerumque 2.5-5 µm crassis. Conidiophoris hyalinis, septatis, primum erectis, basi 3.5-5µm crassis, sursum 1.5-2.5µm crassis, uno conidio gentio 2-25 µm subter apicem a latere identidem repullulantibus et ex incrementis 7-35 µm longis 2-20 alia conidia gerentibus itaque postea usque 270 µm longis aliquantum ramosis degravatisque. Conidiis hyalinis, plerumque fusiformibus, cylindraceis, apice rotundatis, basi truncatis, 1-6-septatis (plerumque 3-4-septatis), 26-51 µm (saepius circa 41 µm) longis, 2.5-6.3 µm (saepius circa 4.8 µm) crassis.

Etymology: The species epithet refers to its habitat.

Holotype: *HT1.00596*, Xiaobailong Mount, Kunming City, Yunnan Province, P. R. China, 10 Sep 2003, MingHe Mo. The holotype and its living culture (YMF1.00596) are deposited in the Laboratory for Conservation and Utilization of Bio-resources, Yunnan, P. R. China.

Colonies on CMA plates growing slowly, attaining 2.8 cm diam. in 60 days at 28°C, producing brown pigment resulting in medium colored mycelia. Mycelium spreading, vegetative hyphae hyaline, septate and branched, mostly 2.5-5 µm wide. Conidiophores colorless, septate, at first erect, 3.5 to 5 µm wide at the base and 1.5 to 2.5 µm wide above, after attaining a length of 60 to 180 µm producing a terminal conidium and repeatedly growing out laterally 2-25 µm below the apex to produce 2–20 additional conidia on the apices of branches or prolongations often 7-35 µm in length, thereby becoming rather extensively ramified. Conidia colorless, spindle shaped to cylindrical, both ends attenuated, rounded at the tip, truncate at the base, 1–6 septate, usually 3-4-septate (67%), 25-51(41)×2.5-6.3(4.8) µm. On WA, no trapping structures were induced when nematodes were added.

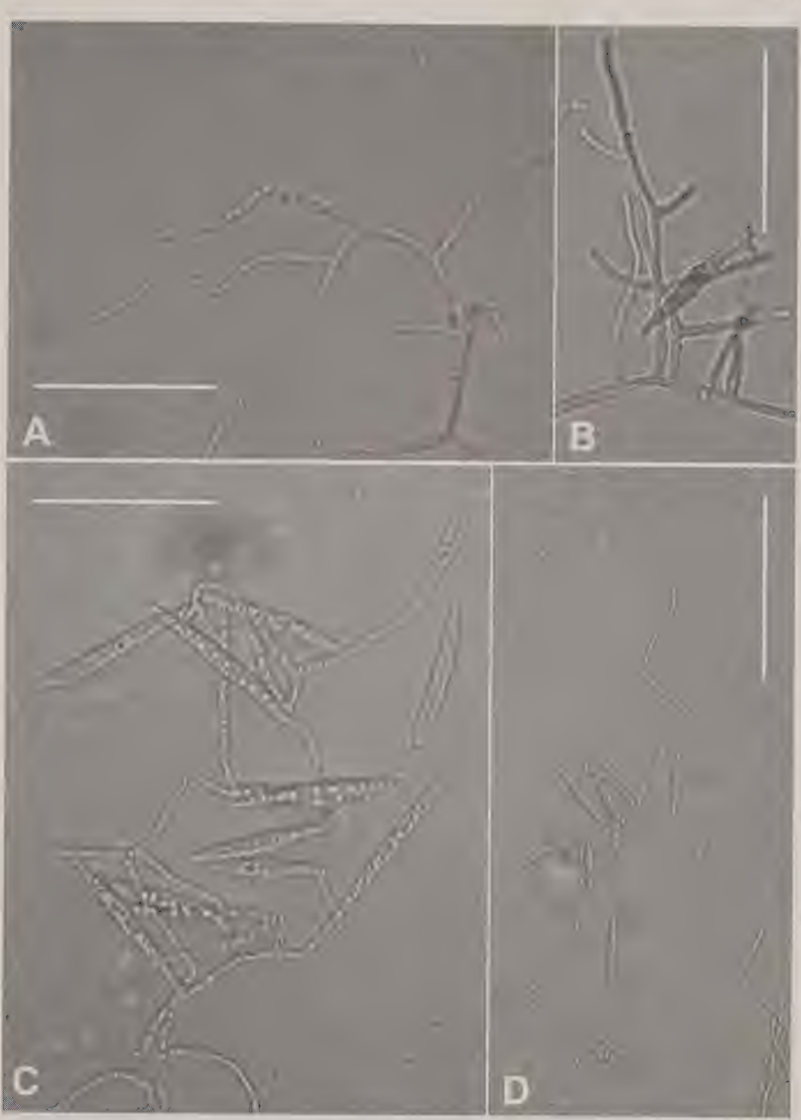

Fig 1. ***Dactylella lignatilis*** **sp. nov.** A-B. Conidiophores. C-D. Conidiophores bearing conidia. Scale bar: A-C=50 µm, D=100 µm.

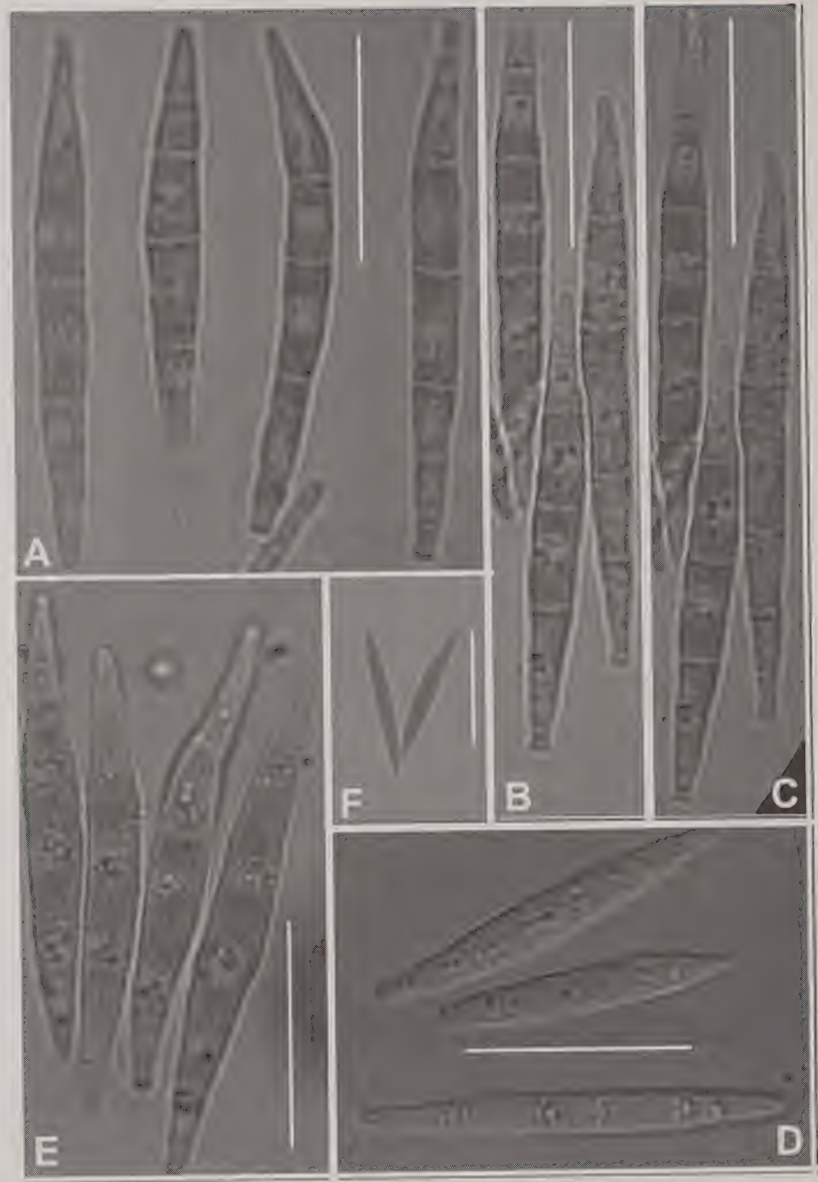

Fig 2. ***Dactylella lignatilis*** **sp. nov.** A-C. Conidia with distinct septa. D-F. Conidia with indistinct septa. Scale bar: A-E=18 μm, F=30 μm.

Teleomorph: ***Hyalorbilia*** **sp.** FIGURE 3

Apothecia, scattered, superficial, sessile, on the periderm of *Pinus* sp.. Disc 2-3 mm diam, concave or plano-concave, pale orange, margin even. Asci 20-25×3.2-4.5 μm (dead state), 8-spored, cylindric, sessile, slightly contracted at the base which is 2.6-3.1 μm wide, arising from croziers, apex broadly rounded, thin-walled. Ascospores cylindric, constantly curved (sickle-shaped), ends obtusely rounded, nonseptate, 5-7×0.8-1.0 μm (dead state, straight distance between the spore ends and widest width). Paraphyses hyaline, slender, not or slightly enlarged at the apex to 2-3 μm diam, and 1-2 μm diam below, equal to the asci, their apices agglutinated and encrusted to form a thin epithecial layer. Ectal excipulum formed of angular to prismatic hyaline cells, with thin or slightly thickened walls, mostly 10-20×6.5-12 μm.

Specimen examined: *MMH005*, Xiaobailong Mount, Kunming City, Yunnan Province, P. R. China, 10 Sep 2003, MingHe Mo. It was collected from the periderm of a decayed twig of *Pinus* with one end submerged into the moist soil.

Discussion

The genus *Dactylella*, which was established by Grove (1884) based on the type *D. minuta*, is characterized by having elongate, solitary, acrogenous, and multiseptate conidia. The circumscription of the genus was emended several times by different authors and was summarized by Miao et al. (2003) in detail. Here we prefer to place the new species in *Dactylella* following the generic concept of Subramanian (1963), who mainly characterized *Dactylella* as having cylindrical, ellipsoidal, clavate or fusoid conidia (without a large inflated central cell) solitarily borne on the conidiophore.

Dactylella lignatilis grows slowly on CMA medium and begins to produce conidiophores and conidia after incubation for about 30 days at 28°C. The new species fails to trap nematodes when challenged with the saprophytic nematode *Panagrellus redivivus* on water agar medium. *Dactylella lignatilis* resembles *D. anisomeres* Drechsler, *D. atractoides* Drechsler, *D. cylindrospora* (R.C. Cooke) A. Rubner, *D. spermatophaga* Drechsler, and *D. stenocrepis* Drechsler in conidial shape, size, septation, and the manner of conidiophore branching or saprophytic habit, but can be distinguished as follows. *D. anisomeres* forms smaller conidia (20-43×3.5-4.5 μm) with 1-5 (often 3) septate on branched conidiophores and parasitizes oosporic fungi (Drechsler 1961). Like *D. lignatilis*, *D. atractoides* is a saprophytic species and forms extensively ramified conidiophores, but the fungus produces spindle conidia with 3-13 (mainly 10) septa (Drechsler 1943). *D. cylindrospora* produces cylindrical or obovoid conidia with 1-4 (usually 3) septa on denticles of unbranched rather than branched conidiophores (Cooke 1969). *D. spermatophaga* produces longer and slightly curved conidia, 35-65(50)×3.8-5.2(4.5) μm, with 2-4 (often 3) septa on unbranched or branched conidiophores and parasitizes oosporic fungi (Drechsler 1938). *D. stenocrepis* produces conidia similar to *D. lignatilis* in septation and size, but its conidia are often prolonged at the narrow base and slightly curved at the tip (Drechsler 1961).

The genus *Hyalorbilia* was created by Baral and Marson (2001) based on unstalked asci arising from croziers, with hemispherical apices without wall thickenings,

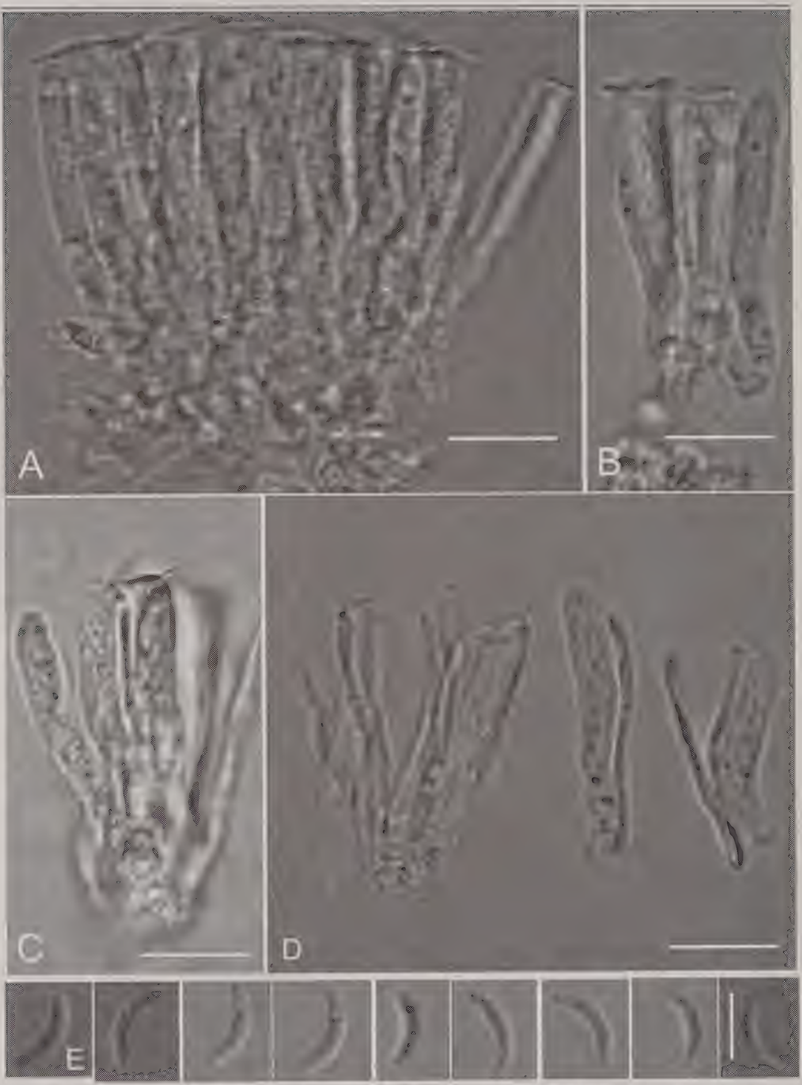

Fig 3. ***Hyalorbilia* sp.** A-D. Asci and paraphyses. E. Ascospores. Scale bar: A-D=9 μm, E=4 μm.

hymenial elements conglutinate in a gelatinous matrix, homopolar ascospores with a mostly bipolar-symmetrical guttule pattern in the living state, an ectal excipulum of horizontally oriented textura prismatica, and not or only slightly inflated paraphyses. The morphology of our teleomorphic specimen is close to that of *H. inflatula* (P. Karst.) P. Karst., which is characterized by its narrow, cylindrical, straight, or very slightly curved ascospores; broad, sessile, cylindrical asci; and not or only slightly inflated paraphyses (Spooner 1987). But the ascospores of our specimen are always medium curved rather than straight or only very slightly curved. On the same *Pinus* branch where our *Hyalorbilia* grew, we also collected the apothecia of *H. inflatula* (det. H.O. Baral). Yet, we confirmed that *D. lignatilis* is clearly the anamorph of the unidentified species of *Halorbilia* and not that of *H. inflatula* after examination of the specific apothecia that produced the anamorphic colonies. Another similar species is *H. citrina* (A.L. Smith) Baral & Marson, which is characterized by its cylindrical, distinctly helicoid ascospores and usually very thick-walled excipular cells (Baral pers. comm.); these two features were not observed in our specimen.

Acknowledgments

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Amanita aprica—a new toxic species from western North America

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Abstract—*Amanita aprica* is described as new based on material from the states of California, Oregon, and Washington in the U.S. and the province of British Columbia in Canada. Comments on some similar taxa are included: *Amanita breckonii*, *A. gemmata*, and entities commonly included in *A. muscaria*. Brief notes on the apparent toxicity of *A. aprica* are included.

Key words—*Amanitaceae*, taxonomy, mushroom poisoning

Our continuing studies in *Amanita* Pers. in the northwestern part of the contiguous 48 states of the U.S.A. indicate several undescribed taxa are present in this region. In this paper we describe one such assignable to *Amanita* section *Amanita.* In the past, *Amanita aprica* (Fig.1) may have been misdetermined as *A. gemmata* (Fr.) Bertillon *in* Dechambre or a variety of *A. muscaria* (L.:Fr.) Pers. For earlier reports on *Amanita* in the region of interest see (Tulloss 1994, 1998; Tulloss and Lindgren 1992, 1994).

Methods

The methods used in this paper follow those of Bas (1969) and Tulloss *et al.* (1992) as modified by Tulloss (1993, 1994, 1998, 2000). For the convenience of the reader, we repeat definitions of some biometric characters used in recent publications:

L = range of the average spore length computed per specimen examined
L´ = average spore length computed for all spores measured
W = range of the average spore width computed per specimen examined
W´ = average spore length computed for all spores measured
Q = observed range of the ratio of length/breadth for all spores measured
Q = range of the average value of Q computed per specimen examined
Q´ = average value of Q computed for all spores measured
w_{cs} = width of the central stratum of a lamella
w_{st}-near = distance from an outer margin of the central stratum to the nearest base of a basidium

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w_{st}-far = distance from an outer margin of the central stratum to the farthest base of a basidium on the same side of the central stratum.

The term "subhymenial tree" is used for that portion of a lamella comprising diverging elements located between the central stratum and the hymenium. The subhymenial tree excluding the subhymenium is termed the "subhymenial base."

Macrochemical spot tests for tyrosinase and laccase follow the methods of Marr (1979). Holmgren, Holmgren and Barnett (1990) are the source of herbarium name abbreviations used in this paper with two exceptions: JEL—private herbarium of Lindgren; RET—private herbarium of Tulloss. In descriptions of collecting localities, "BLM" stands for "Bureau of Land Management"; "MHNF," for "Mount Hood National Forest"; and "GPNF," for "Gifford Pinchot National Forest."

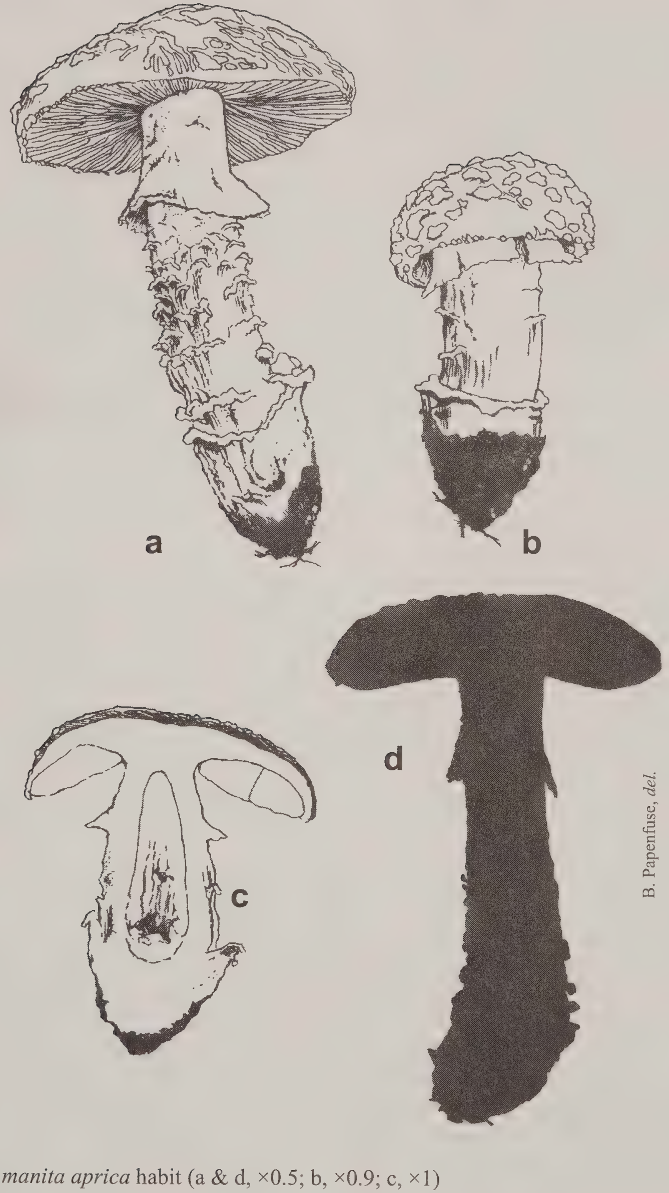
Taxonomic part

AMANITA APRICA J. Lindgr. & Tulloss *sp. nov.*

> *Pileus* 50 - 150 *mm latus, flavissimus vel vitellinus vel citrinus vel aurantioflavus, initio globosus, demum convexus vel plano-convexus, postremo planus, subviscidus; margine non vel nonnihil striato, integro; carne alba,* 6 - 20 *mm crassa. Lamellae liberae vel secedentes, confertae vel subdistantes, albae vel eburneae,* 5 - 12 *mm latae, fimbriatae; lamellulae truncatae, numerosae. Stipes* 33 - 91 × 16 - 35 *mm, albus vel eburneus, plerumque cylindricus, pruinosus vel flocculosus, bulbo basali saepe indistincto,* 16 - 34 × 18 - 40 (-50) *mm, basi rotundata vel acutà; carne alba; annulo supero vel medio, albo vel eburneo, membranaceo, fragili, interdum evanido. In pileo, velum universale album vel eburneum, detersili, fibrilis tenuibus, appressis, verrucis parvis, floccosis vel tegmine floccoso-coacto, prope completo. In bulbo basali stipitis, velum universale margine libero, interdum annulis detersilibus in stipite inferno, albus vel eburneus. Sporae* (8.0-) 9.5 - 13.0 (-21) × (5.0-) 6.5 - 8.5 (-12.5) *µm, late ellipsoideae vel ellipsoideae* (**Q** = (1.38-) 1.42 - 1.62 (-1.80)), *inamyloideae. Fibulae infrequentes. Habitat in apricis. Holotypus:* UNITED STATES OF AMERICA, Washington, border of Klickitat & Skamania Cos., Trout Lk., 28.v.1994 J. E. Lindgren 94-07 (WTU).

Etymology: *apricus*, growing in the sunshine, exposed to the sun, sunny; because of the species' being found most often in places exposed to direct sun and because of the bright "apricot-like" color of the pileus.

PILEUS: 50 - 150 mm wide, bright yellow to egg yellow to lemon yellow or bright orangish yellow, occasionally orange (especially over disc), colors sometimes fading and becoming duller after exposure to sun, globose at first, then convex to plano-convex, finally plane with or without disc depressed, glabrous, tacky to subviscid where pileipellis exposed at maturity or in moist weather; *context* white, yellow under pileipellis, 6 - 20 mm thick at stipe, thinning evenly to less than 2 mm at margin; *margin* nonstriate or faintly striate (even in age), entire, inrolled at first, slightly uplifted in age, sometimes bearing fragments of partial veil; *universal veil* as thin appressed downy fibrils or small floccose warts or patches or as a nearly complete floccose-felted to "woolly-felted" covering, or as a nearly complete covering of confluent broadly subpyramidal warts, white to creamy white to yellowish white, detersile,



B. Papenfuse, *del.*

Fig. 1. *Amanita aprica* habit (a & d, ×0.5; b, ×0.9; c, ×1)

quite commonly remaining attached over much of pileipellis and becoming thinner as stretched by expanding pileus.

LAMELLAE: free to seceding, with faint decurrent lines on stipe apex, close to subdistant, white to creamy white in mass and in side view, unchanging when cut or bruised, 5 - 12 mm broad, broadest at midpoint, with fimbriate sometimes uneven edges; *lamellulae* truncate to excavate-truncate, numerous.

STIPE: 33 - 91 × 14 - 35 mm, white to cream to creamy tan, bruising light tan where handled, usually cylindric, occasionally narrowing upward, surface pruinose to flocculose to scurfy below partial veil, flocculence in young specimens easily removed by handling; *bulb* often not distinct, merely clavate base of stipe, (10-) 16 - 34 × 18 - 40 (-50) mm, with either rounded or pointed base, sometimes slightly radicating; *context* white to pale yellow, infrequently with brownish stains in spots on cut surface, firmly stuffed with white tissue when young, becoming hollow or partially hollow; *partial veil* superior to median, white to cream, felted-membranous at first, soon fragile, skirt-like, sometimes collapsing on stipe, sometimes evanescent; *universal veil* as low free limb encircling top of bulb, white to cream to creamy tan to pale tan, seldom rolled outward, 1 - 3 mm thick at about half height of limb, 25 - 38 mm from base of bulb to highest point on limb, sometimes also as detersile rings on lower stipe above limb, also often left in soil or as patches or warts on stipe.

Odor and *taste* not distinctive.

MACROCHEMICAL TESTS: 10-20% KOH - partial veil turning orange in less than 5 min., context of pileus and stipe pale yellowish. NH_4OH - context of pileus and stipe slightly yellow in 5 min., fading. H_2SO_4 (dilute) - negative. $FeSO_4$ - negative. Ethanol - negative. Phenol - wine red spot in pileus context and upper stipe after 10 min. Spot test for tyrosinase (paracresol) - positive (reddish brown) in stipe context near stipe base, partial veil, and pileus context in 10 min. Spot test for laccase (syringaldazine) - negative throughout basidiocarp. Macrochemical test voucher: Lindgren 92-5. POISONOUS: producing nausea, vomiting, intestinal cramps, muscle spasms, diarrhea, disorientation, and hallucinations, with these accompanied by drowsiness and the desire to sleep.

PILEIPELLIS: 295 - 300 μm thick at approximately midradius, up to 440 (-535) μm thick in disc, entirely ungelatinized well beyond initiation of sporulation in most specimens and, hence, lacking distinctive supra-/subpellis, with most elements subradially oriented, with occasional regions below upper surface having many elements distinctly nonradial; filamentous, undifferentiated hyphae 1.8 - 7.0 μm wide, branching, densely packed vertically, with many at and near upper surface connected to universal veil well into maturity in most specimens, with hyphae and inflated cells like those of universal veil sometimes arising below uppermost hyphal layers (Fig. 2b); vascular hyphae 3.0 - 19.6 μm wide, branching, sinuous, scattered to locally common, sometimes entangled, occasionally crossing ungelatinized into universal veil well into maturity. PILEUS CONTEXT: filamentous, undifferentiated hyphae 0.6 - 9.3 μm wide, branching rather frequently, plentiful, sometimes in fascicles, sometimes with yellowish subrefractive walls, forming open lattice-like structure; acrophysalides plentiful, terminal and solitary, narrowly clavate to clavate (up to $222^{\pm}$ × $51^{\pm}$ µm) or broadly clavate to ellipsoid (up to 108 × 47 µm); vascular hyphae 3.0 - 23 µm wide, branching, sinuous, infrequent, locally common (especially in upper part of context). LAMELLA TRAMA: bilateral, markedly divergent, rather broad; w_{cs} = 95 - 135 µm (very good rehydration); central stratum including numerous intercalary partially inflated to narrowly ventricose cells (*e.g.*, 154 × 18.2 µm); angle of divergence from very shallow to about 45°; filamentous, undifferentiated hyphae 1.0 - 10.5 µm wide, frequently branching, sometimes with yellowish tint, sometimes with constrictions at septa, occasionally markedly changing diameter at septa; divergent inflated cells broadly to narrowly clavate to narrowly ventricose to only slightly inflated, sometimes slightly curved, up to 117 × 32 µm (commonly about half this size), apparently all intercalary; vascular hyphae 4.5 - 9.3 µm wide, rare; clamps infrequent in subhymenial base, not observed elsewhere. SUBHYMENIUM: w_{st}-near = 80 - 115 µm (very good rehydration); w_{st}-far = 100 - $135^{\pm}$ µm (very good rehydration); (2-) 3 - 4 (-5) layers of cells thick, with basal layer cells arising from hyphal segments or inflated intercalary cells, generally appearing subcellular to cellular, with (however) basidia arising from both subglobose to barrel-shaped cells and occasionally from only slightly inflated hyphal segments; clamps infrequent to rare. BASIDIA: 48 - 70 × 10.0 - 11.5 µm, projecting up to 12.0 - 16.0 µm beyond surrounding basidioles, dominantly 4-, occasionally 2-sterigmate; sterigmata up to 5.8 × 4.0 µm; clamps and proliferated clamps unevenly distributed, infrequent, sometimes small and very thin-walled, requiring persistent search. UNIVERSAL VEIL: *On pileus*: with substantial number of filamentous, undifferentiated hyphae and some vascular hyphae connecting to pileipellis often well into maturity, with gelatinization beginning in hyphae near base simultaneously with some hyphae of pileipellis surface, with elements having subvertical to vertical orientation; filamentous, undifferentiated hyphae 3.0 - 8.0 µm wide, branching, plentiful to dominant in base, plentiful above basal region; inflated cells plentiful, terminal singly, broadly to narrowly ellipsoid (up to 78 × 40 µm), broadly to narrowly clavate (up to 105 × 50 µm), sometimes slightly constricted; vascular hyphae 4.2 - 11.5 µm wide, scattered to locally clustered, sinuous, occasionally branching, occasionally entangled locally. *On stipe base, exterior surface*: filamentous, undifferentiated hyphae in broad (but not very thick) interwoven fascicles, partly gelatinized. *On stipe base, interior*: filamentous undifferentiated hyphae 1.8 - 12.6 µm wide, branching, dominating, sometimes constricted at septa, sometimes with yellowish walls, plentiful, often dominating; inflated cells terminal, singly or in chains of two, globose to broadly globose to pyriform (up to 55 × 52 µm) or broadly ellipsoid to broadly clavate to ellipsoid to elongate (up to 64 × 39 µm), plentiful; vascular hyphae not observed. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 1.4 - 9.1 µm wide, branching, sometimes in narrow fascicles, sometimes with yellowish subrefractive walls, dominantly longitudinally oriented, dominating near surfaces, plentiful in interior; acrophysalides plentiful, smaller and less frequent toward surfaces, plentiful in interior, up to 195 × 37 µm; vascular hyphae 3.2 - 28 µm wide, sinuate to hypersinuate, sometimes loosely coiled (corkscrew-like), unevenly distributed, scattered to locally common, yellowish.

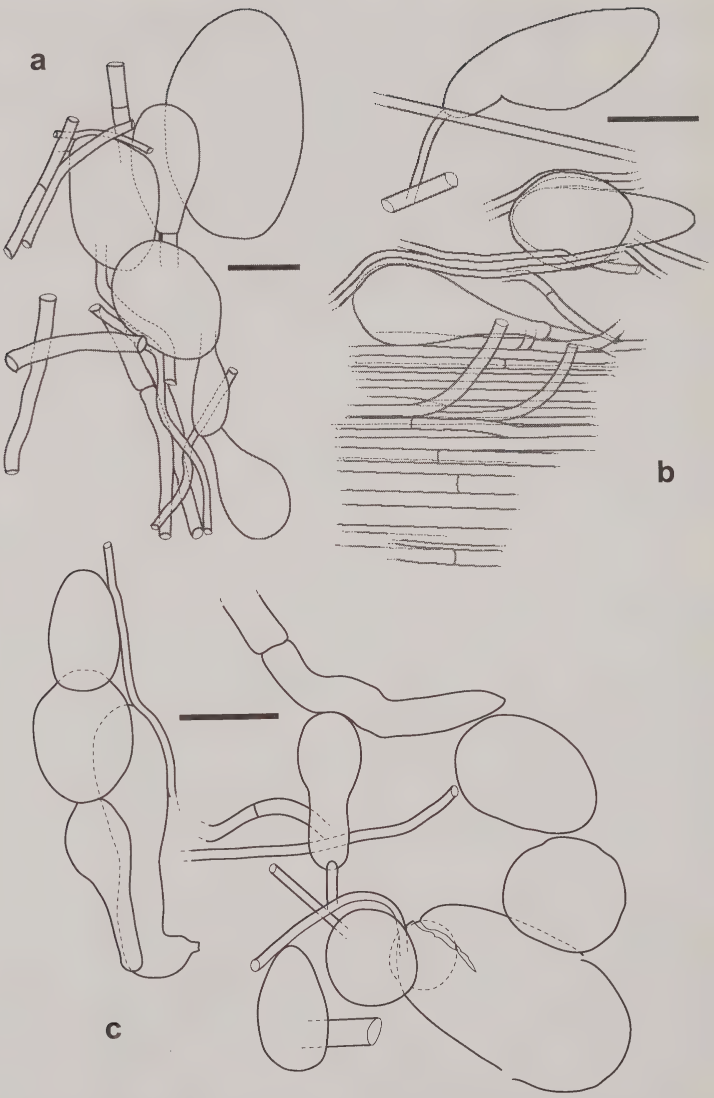


Fig.2. *Amanita aprica* (holotype). (a) Elements of universal veil from interior of limb above bulb on stipe base (crush mount with some hyphae not shown). (b) Elements of base of universal veil from pileus showing connection to pileipellis. (c) Elements of universal veil from pileus (upper portion, crush mount, some hyphae not shown). Scale bars equal 20 μm.

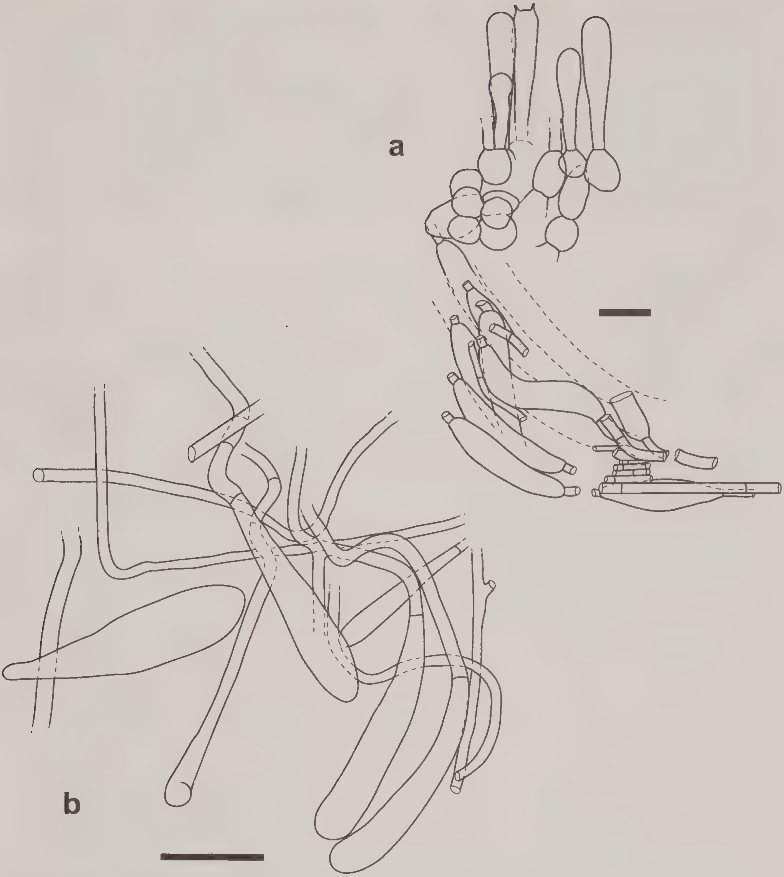


Fig.3. *Amanita aprica.* (a) Elements of hymenium and lamella trama (holotype, with elements occasionally displaced by sectioning—*e.g.*, apparently sinuate intercalary element in subhymenial base). (b) Elements of partial veil excluding any cells remaining from former attachment to edges of lamellae (Trudell 96-165-01, crush mount, some hyphae omitted).

PARTIAL VEIL: filamentous, undifferentiated hyphae 2.1- 4.4 μm wide, branching, dominating, disordered except for occasional fascicles up to 10 hyphae wide, sometimes with yellowish subrefractive walls; inflated cells plentiful, narrowly cavate, terminal, usually singly, occasionally subtended by a smaller somewhat inflated hyphal segment, up to 88 × 17.6 μm wide, infrequently producing hyphae laterally or apically; vascular hyphae not observed.

BASIDIOSPORES: [1331/66/27] (8.0-) 9.5 - 13.0 (-21) × (5.0-) 6.5 - 8.5 (-12.5) µm, (**L** = (9.8-) 10.1 - 12.2 (-13.1) µm; **L′** = 11.1 µm; **W** = (6.6-) 6.8 - 8.1 (-8.4) µm; **W′** = 7.4 µm; Q = (1.22-) 1.35 - 1.71 (-2.13); **Q** = (1.38-) 1.42 - 1.62 (-1.80); **Q′** = 1.52), hyaline, colorless, smooth, thin-walled, inamyloid, ellipsoid to elongate, occasionally broadly ellipsoid, often adaxially flattened, sometimes swollen at one end, occasionally langeniform, infrequently "giant"; apiculus sublateral, cylindric to truncate-conic, proportionately rather large; contents granular to mono- or multiguttulate, dominantly monoguttulate with additional small granules; white to creamy white in deposit.

Distribution and habitat: Solitary to gregarious, at 600 - 1850 m elev. Often in sunny locations such as road cuts, along trails, campgrounds, and under other breaks in the forest canopy; occurring with conifers, mainly *Pseudotsuga menziesii* (Mirb.) Franco, less frequently with *Pinus* (*e.g.*, *P. contorta* Dougl. *ex* Loud., *P. monticola* Dougl. *ex* D. Don, and *P. ponderosa* Dougl. *ex* Laws.). For example, basidiocarps of Lindgren 90-23 collected under *P. monticola* with understory of *Achlys triphylla* (Sm.) DC, *Pachistima myrsinites* (Pursh) Raf., *Vaccinium sp.*, *Pyrola sp.*, and grass; quite common in the Cascade Mountains of Oregon and Washington.

Collections examined: **CANADA**: BRITISH COLUMBIA—Brackendale, 2.v.1993 P. Kroeger 1658 (DAVFP (*n.v.*); RET; UBC (*n.v.*)). **UNITED STATES**: CALIFORNIA—Sierra Co. - N of Downieville, *ca.* Hwy. 49, 5.vii.2003 Mark Lockaby "A" (RET); Sierra Nevada Field Camp on Hwy. 49, 6.vi.1986 R. E. Halling 4659 (NY). Tulare Co. - *ca.* Sequoia Nat. Pk., 14.ix.1991 Bruce Kuechman *s.n.* [Lindgren 91-28] (RET). No county given—Sierra Nevada, 5.vi.2003 Mark Lockaby "B" (RET). OREGON—Clackamas Co. - BLM Table Rock Tr., 8.vi.1994 J. E. Lindgren 94-8 (JEL; RET); MHNF, Salmon Butte Tr., 16.vi.1990 J. E. Lindgren 90-7 (JEL; RET); MHNF, Salmon R. Tr., 5.vi.1991 J. E. Lindgren 91-19 (JEL; RET). Hood River Co. - MHNF, Pebble Ford Campgrd., 27.vi.1990 Dick Bishop *s.n.* [Lindgren 90-11] (JEL; RET); MHNF, Rd. 48, 19.v.1994 J. E. Lindgren 94-4 (JEL; RET); MHNF, Surveyor's Ridge, 1991 J. E. Lindgren 91-21 (JEL; RET). Multnomah Co. - *ca.* Portland, 30.v.1990 poisoning victim (Bulgarian immigrant) *s.n.* [Lindgren 90-13] (JEL; RET). County & locality unknown, 3.v.1988 member of Oregon Mycol. Soc. *s.n.* [Lindgren 116] (JEL; RET). WASHINGTON—Chelan Co. - Wenatchee Nat. For., at boundary of Glacier Peak Wilderness, ca. tr. to Twin Lakes, 14.vi.1997 J. E. Lindgren 97-2 (JEL; RET). King Co. - Mt. Baker-Snoqualmie Nat. For., E of Enumclaw & W of Mt. Ranier Nat. Pk. entrance, St. Hwy. 410, Dalles Campgrd., 30.iv.1992 Steve Trudell *s.n.* [Lindgren 92-16] (JEL; RET); Snoqualmie Nat. For., on Rd. 54, 1.6 km S of Stampede Pass (1.3 km S of Lizard Lk.), less than 0.2 km from point where power lines cross rd., 13.vi.1996 Steve Trudell 96-165-01 (JEL; RET). Kittitas Co. - Wenatchee Nat. For., E of Snoqualmie Pass, 5.4 mi NE of U.S. Interst. Hwy. 90 on For. Rd. 228, Kachess Campgrd., 11.v.1992 Steve Trudell *s.n.* [Lindgren 92-18] (JEL; RET). Border Klickitat & Skamania Cos. - Trout Lk., 30.v.1987 J. E. Lindgren *s.n.* [Tulloss 5-30-87-JL1] (JEL; RET); 28.v.1994 J. E. Lindgren 94-07 (holotype, WTU; isotype, JEL; isotype, L; isotype, NY; isotype, RET). Skamania Co. - GPNF, 6.5 km N of Beacon Rock St. Pk., 22.v.1997 J. E. Lindgren 97-4 (JEL; RET); GPNF, ca. Goose Lk., 18.vi.1990 J. E. Lindgren 90-23 (RET); GPNF, Rd. 80 to Morrison Crk. Cmpgrds., *ca.* Trout Lk., 5.vi.1990 J. E. Lindgren 90-18 (JEL; RET); GPNF, Morrison Crk., Road 80, 7.vi.1990

J. E. Lindgren 90-19 (JEL; RET); GPNF, Takhlakh Lk., 8.vi.1989 J. E. Lindgren 139 [89-39] (JEL; RET); GPNF, Trout Lk., vi.1991 J. E. Lindgren 91-18 (JEL; RET), 23.v.1995 J. E. Lindgren 95-3 (JEL; RET); GPNF, Trout Lk. Cr. valley, Rd. 8810, 2.v.1992 J. E. & P. Lindgren & Frank Kopecky [Lindgren 92-17] (JEL; RET); GPNF, Trout Lk. Ranger Distr., Rd. 23, 22.v.1994 Shirley Boothby *s.n.* [Lindgren 94-05] (JEL; RET); GPNF Trout Lk. Ranger Distr., Rd. 23 & Rd. 8040, 7.vi.1991 J. E. Lindgren 91-20 (JEL). Thurston Co. - Olympia, Evergreen St. Coll. parking area, 1992 Michael Beug *s.n.* [Lindgren 92-5] (JEL; RET).

Discussion

Amanita aprica is assignable to *Amanita* section *Amanita*. For many years in the Pacific Northwest of the U.S.A., *A. aprica* has been identified as other taxa of that section: *Amanita muscaria* var. *formosa* Pers., *A. gemmata,* or *A. jonquillea* Quél.—also spelled "*junquillea*"—a posterior synonym of *A. gemmata*. It seems very likely to have been treated by Nakamura (1965) as both a "form" of *A. junquillea sensu* Nakamura having ellipsoid spores and as "form B" of *A. muscaria* var. *formosa sensu* Nakamura. Regrettably, none of Nakamura's personal collections are to be found at WTU.

Although its macroscopic appearance sometimes suggests otherwise (and, indeed, some collections thought at first to be *A. aprica* and examined during the work on this paper proved to be *A. muscaria* subsp. *flavivolvata* Singer), *A. aprica* is readily segregatable from all the described varieties of *A. muscaria* and phenetically closely related taxa by the fact that these all bear common to plentiful basidial clamps.

One collection thought at first to be *A. aprica* proved to be *A. breckonii* Thiers & Ammirati (1982). Tulloss has examined the type of *A. breckonii* and found the latter species differs from *A. aprica* at least in having

- spores proportionately narrower, with **Q** = (1.51-) 1.52 - 1.74 (-1.85) and **Q′** = 1.63
- locally common basidial clamps
- submedian partial veil
- pileus margin becoming distinctly tuberculate-striate in age
- pileus disc often becoming *Cinnamon Buff* (1Y 7.2/6.0) in age.

The supposed double annulus of *A. breckonii* comprises a weakly structured partial veil and, below this, a substantial ring of tissue of the *limbus internus* of the universal veil. The latter has a triangular cross-section having its apex pointing upward—strongly suggesting a second partial veil at first glance. In the several exsiccata of *A. breckonii* examined by Tulloss, the "lower annulus" is not always present.

Amanita gemmata (the European "taxon" may be a complex of several entities) can be distinguished from *A. aprica* by means of the following characteristics:

- spores proportionately broader than those of *A. aprica*, having **Q** = 1.29 - 1.36 (Tulloss and Gulden 1999) or with **Q** = 1.42 ± 0.13 (Yang and Doi 1999) or with **Q'** = 1.31 based on data of Neville and Poumarat (2004: 381) or, estimating from data of Breitenbach and Kränzlin (1995), having **Q** approximately 1.25 - 1.27.

- universal veil on pileus dominated by filamentous, undifferentiated hyphae disordered or with subradial orientation and also including scattered or locally fairly abundant inflated cells (Yang 1997: 51).
- pileus color ranging from yellow-orange (material of southern France) to tannish shades of yellow to pale tan (material of Norway) to nearly white with tan restricted to disc (material of Turkey)
- pileus margin distinctly striate
- basidiocarps more gracile and with cap width reaching only about a bit more than half (Marchand 1971; Neville and Poumarat 2004: 380) to two-thirds the maximum size of those of *A. aprica* (Bresinsky and Besl 1990; Persson 1992; Breitenbach and Kränzlin 1995).

Kauffman (1926: 122-123) describes material from Mt. Hood determined by him as *A. jonquillea* with spores 10-12 × 7-8 mm (his comments indicate that he excludes extremes of length and, hence, presumably, width). It is very possible that Kauffman's material determined as *jonquillea* is assignable to *A. aprica*.

The habit and spores described for *A. muscaria* var. *formosa sensu* Nakamura are rather good matches to the habit and spores of *A. aprica*. In addition, Nakamura's "form B" is the only yellow entity of *Amanita* section *Amanita* described by Nakamura that occurs in the April-June period—apparently the most common fruiting period for *A. aprica*—indeed, all our collections from Oregon and Washington were made in this period.

While accepting with minimal comment Nakamura's observations on *A. muscaria*, Breckon (1968: 51-57) appears to have interpreted *A. aprica* as "montane specimens" of "*Amanita junquillea sensu* A. H. Sm." Among the characters noted for the "montane specimens," Breckon includes a pileus with nonstriate margin and universal veil tending to cover much of the surface. The fruiting period for these specimens is described as "late spring through the autumn," which is compatible with the dates of collection of the California paratypes of *A. aprica*.

North American taxa referred to *A. gemmata* include *A. russuloides* (Peck) Sacc. 1887 (Jenkins 1977), *A. xylinivolva* Tulloss, Ovrebo and Halling (1992), and several apparently distinct, undescribed species. Both of the above-named species are smaller and more gracile than *A. aprica*; both have striate margins; and both have proportionately broader spores.

Asian species, including those recently described by Zhu L. Yang and others, do not include any taxa that are comparable with *A. aprica* in all of the following: color, stature, form of universal veil, and spore dimension and shape.

Lindgren 92-5 and 94-08 and Lockaby "A" (so marked by Tulloss) comprise immature material.

In correspondence and keys, we have used the code "*Amanita sp. NW2*" for *A. aprica*.

In several sections of *Amanita*, there have been noted taxa that characteristically fail to produce, or delay in producing, a gelatinizing zone allowing separation of pileipellis and universal veil.

In subsection *Vittadiniae* Bas of *Amanita* section *Lepidella*, as well as in other notable species of that section such as *A. rhoadsii* (Murrill) Murrill and *A. magniverrucata* Thiers & Ammirati, the universal veil remains long attached to the pileus context and a pileipellis is reduced to a layer of context including rather densely placed hyphae or, quite often, is entirely absent.

In other sections, a freshly opened pileus may have a frosty appearance caused by the dense distribution of hyphal stubs projecting upward from the ungelatinized or minimally gelatinized pileipellis after a submembranous or membranous universal veil has been pulled away during expansion of the basidiome.

In section *Amanita*, in particular, there are a number of taxa that retain much of the universal veil on the pileus because of delayed or absent gelatinization—as has been noted in *A. aprica*. Some examples are *A. basiana* Tulloss & M. Traverso, *A. farinosa* Schwein., *A. friabilis* (Karst.) Bas, *A. nehuta* G. S. Ridl., and *A. xerocybe* Bas. The long-term attachment of pileipellis and universal veil does not appear to be a character that should be considered justification for grouping *A. aprica* taxonomically with these other taxa. The above group is characterized by the following: Significantly smaller basidiomes (and consequent markedly striate pileus margins), frequent absence of a partial veil (in the single exception, *A. basiana*, the partial veil is very weakly structured and detersile), powdery universal veil, and spores with **Q** between 1.0 and 1.35 (95% of *A. aprica* spores have Q falling above this range).

Observations on toxicity

We know of one poisoning involving the present species. On May 30, 1990, Lindgren was involved as the mushroom identifier in a case involving an 80 year-old Bulgarian immigrant who spoke no English. He had eaten a frying pan full of *A. aprica* spread over both breakfast and lunch and, possibly, sampled the mushroom the previous day. The number of fruiting bodies ingested was not established. There were four remaining mushrooms cleaned, but uncooked upon which the determination was based (Lindgren 90-13).

One and one-half hours after lunch, the victim began to feel ill with symptoms that included nausea, vomiting, intestinal cramps, muscle spasms, hallucinations, disorientation, and diarrhea. The exact order of progression of symptoms is not known. Drowsiness and the desire to sleep accompanied the other symptoms. When the victim was taken to the hospital that afternoon, a mild heart attack was suspected at first, but no irregularities were seen on an EKG. By 10:30 pm the same day, the victim was very tired and sleepy, still had diarrhea; and an uncontrollable twitching was observed in his arms, shoulders, and chest. Unfortunately, method of treatment and length of hospital stay are both unknown in this case.

While the victim's son did not seek medical treatment, he apparently ingested a small piece of mushroom on May 29, 1990; and, at 10 pm the following day, complained of his tongue "feeling strange" and pain near his liver.

The symptoms manifested in the above case are similar to those of *A. muscaria* intoxication; and, considering the taxonomic placement of *A. aprica* in section *Amanita*, ibotenic acid and muscimol are possibly to be found when the species is assayed for toxins. The similarity to *A. gemmata* both macro- and microscopically suggested to us that we should check literature concerning toxins in the latter species. The literature is confusing and possibly involves at least some misidentifications. Basically, we have to assume that the toxins in *A. aprica* and similar taxa are unknown through most, if not all, of the world.

The European species is said to be edible by Marchand (1971), although he did record a case of ingestion of *A. gemmata* involving sweating, flatulence, and vomiting. Breitenbach and Kränzlin (1995) state that the species is poisonous, but not deadly, while stating that *A. muscaria* is considered deadly by them. Bresinsky and Besl (1990) say that ibotenic acid was reported from something determined as "*A. gemmata*" in the U.S., while a "neuroactive substance behaving pharmacologically like ouabain has been obtained" from Chilean material of the very poorly known *A. toxica* Lazo *nom. inval.*, which was originally determined in Chile as *A. gemmata* or a variety of that species. In a book widely used for diagnosing mushroom poisonings in the U.S., Benjamin (1995) states that the toxic content of [the one or more taxa called] *A. gemmata* in the U.S. is unknown. He also cites reports that the U.S. "*A. gemmata*" is sometimes poisonous and sometimes not. Since we believe that there are four or more taxa misdetermined as "*A. gemmata*" in the U.S. in recent literature and that all differ from *A. aprica*, it is possible that at least one of them has *not* been causing toxic reactions.

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Aliquandostipite crystallinus, a new ascomycete species from wood submerged in freshwater habitats

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Abstract—*Aliquandostipite crystallinus*, a new species of loculoascomycete from wood submerged in freshwater habitats in Costa Rica, Panama, USA (TN), and Venezuela, is described and illustrated. The characteristic features of the new species are sessile, light to dark brown, globose to subglobose, papillate ascomata; broad, brown, septate stoloniferous hyphae connecting adjacent ascomata; large, thin-walled peridial cells; clavate to cymbiform, fissitunicate asci; fusiform, one to three septate, multiguttulate, pale brown ascospores with short, cellular, hyaline, tapering, apical appendages; ascospores surrounded by a long, broad, fusiform gelatinous sheath that elongates in water; and refractive acicular crystals that form within the ascospores and hyphae upon preservation in lactic acid or glycerin. *Aliquandostipite khaoyaiensis* is reported for the first time from the Western Hemisphere in Costa Rica on wood submerged in freshwater streams.

Keywords—aquatic, fungi, Great Smoky Mountains National Park, Loculoascomycetes, taxonomy

Introduction

As part of our ongoing inventories of freshwater filamentous ascomycetes along latitudinal gradients in the Western Hemisphere, collections of woody debris were made from various freshwater habitats. During these inventories, a fungus with morphological characteristics similar to those of the genus *Aliquandostipite* Inderb. (Inderbitzin et al. 2001) was found on submerged wood from Costa Rica, Panama, USA (TN), and Venezuela. Although this fungus is similar in most respects to *A. khaoyaiensis* Inderb., the type of the genus, it differs in lacking stalked ascomata and in having larger ascospores with apical ascospore appendages and an ascospore sheath that tapers at the ends and elongates extensively in water. In addition, refractive, acicular crystals form within the ascospores and hyphae when fixed with lactic acid or glycerin. This characteristic has not been reported nor have we observed it in our collections of *A. khaoyaiensis*. Based on the foregoing differences, the fungus is described and illustrated herein as a new species of *Aliquandostipite*.

Materials and Methods

Submerged woody debris was collected from freshwater habitats and transported to the laboratory in plastic bags containing paper towels. After initial examination, woody debris was incubated in the laboratory in plastic boxes containing moistened paper towels at ambient temperatures (about 24° C) under 12/12h (light/dark) conditions. Samples were examined with a dissecting microscope immediately after collection and periodically for 6–12 months to locate fruiting bodies.

Ascomata were removed from the substrate and crushed in a drop of distilled water on a glass slide. India ink or aqueous nigrosin was added to the aqueous mounts to reveal gelatinous sheaths on or around the ascospores. Single spore isolates were obtained using the procedures of Shearer (1993). Measurements of the physes, asci and ascospores were made of material mounted in distilled water or fixed in lactic acid or glycerin.

Distilled water was replaced with lactic acid containing azure A or with glycerin for preservation using the double cover glass method (Volkmann-Kohlmeyer & Kohlmeyer 1996). Ascomata were fixed and embedded using a modification of Huhndorf's technique (1991) suggested to us by Huhndorf (pers com): the osmium tetraoxide step was deleted, and acetone was used instead of ethanol for dehydration and infiltration. Ascomata were sectioned following the procedures of Fallah and Shearer (2001). Digital images were obtained with a Spot RT digital camera using an Olympus microscope equipped with Nomarski interference and phase optics. Specimens were deposited in the Herbarium of the University of Illinois at Urbana Champaign (ILL).

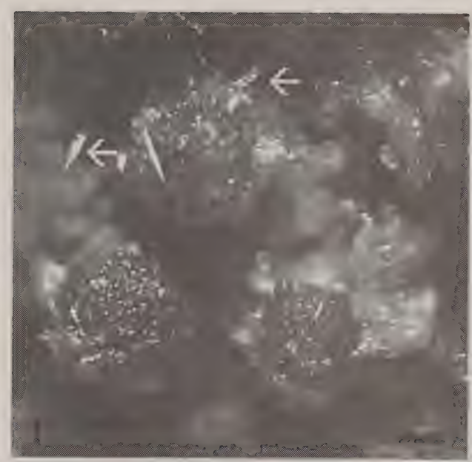
Taxonomic Description

Aliquandostipite crystallinus Raja, A. Ferrer & Shearer Figs. 1–13

> *Ascomata lignatilia 215–270 × 220–320 μm, globosa ad subglobosa, papillata, immersa ad partim immersa vel superficiala, solitaria vel gregaria, primo hyalina demum atrobrunnea. Papilla ca. 30–36 × 60–90 μm, periphysibus. Peridium 21–25 μm, e textura angularis constitutum. Pseudoparaphyses septatae, hyalinae 3–4 μm lata. Asci fissitunicati, octospori, clavati ad cymbiformes, apici rotundato 132–174 × 30–41 μm (mean = 160 × 35 μm, n = 15). Ascosporae tri–vel tetraseriate, fusiforme, multiguttulatae 70–86 × 9–15 μm (mean = 76 × 12 μm, n = 50), primo uniseptatae, demum triseptatae, pallidae brunneae demum atrantes, appendiculatae, crystallinae, tunica grandi, fusiforma, mucilagina, extensa in aqua.*

Colonies on peptone yeast extract agar (PYG) immersed with a mat of aerial hyphae; hyphae septate brown (7–13 μm wide). Hyphal cells containing acicular crystals after storage in lactic acid or glycerin. Ascomata on wood 215–270 × 220–320 μm, hyaline when young becoming dark brown with age (Fig. 1), globose to subglobose, papillate, immersed to partially immersed, or superficial, scattered to clustered, connected by

Figs. 1–5. *Aliquandostipite crystallinus*. (Holotype R076-1). 1. Ascomata on wood, note the subtending hyphae and ascomata shedding wood particles. 2. Longitudinal section of ascoma. 3. Section of papilla showing apically attached pseudoparaphyses. 4. Longitudinal section of ascomal wall, note large hyaline peridial cells. 5. Pseudoparaphyses. Measure bars for Fig. 1 = 150 μm. Fig. 2 = 20 μm. Figs. 3, 4, 5 = 10 μm.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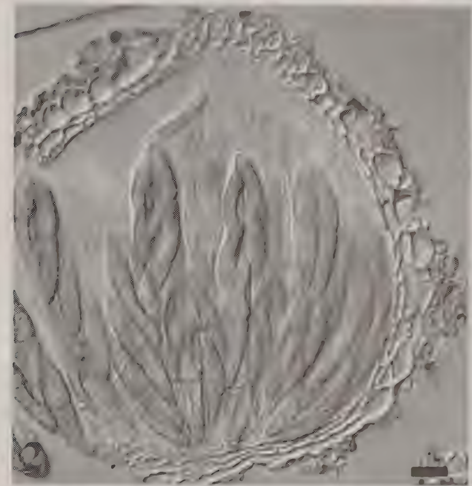
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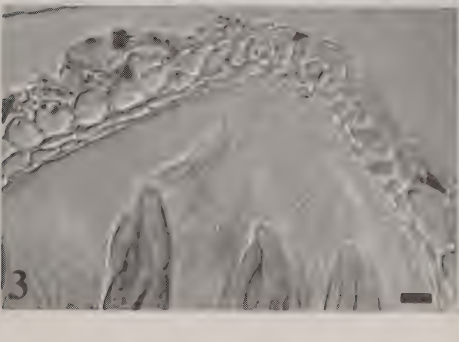
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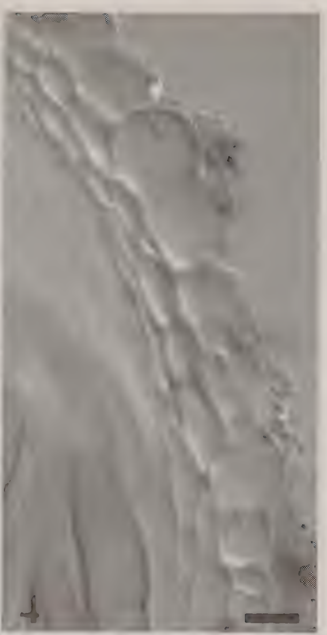
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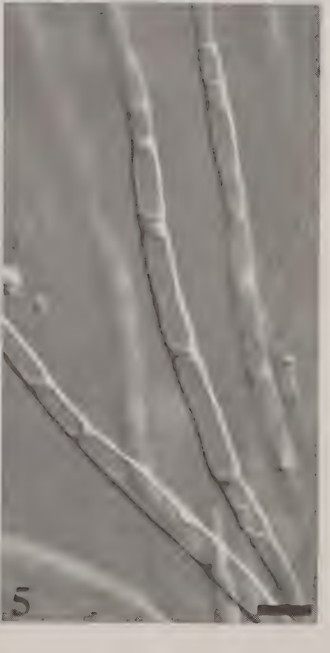
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subtending superficial stoloniferous hyphae ca. 144–170 × 10–13 μm. Papilla ca. 30–36 × 60–90 μm (Figs. 2, 3). Peridium 21–25 μm wide, textura angularis-globosa in surface view, in longitudinal section 2–3 cell layers wide, innermost layer of hyaline thin-walled cells compressed laterally, outermost layer of large thin-walled isodiametric cells 17–22 μm wide (Fig. 4). Pseudoparaphyses septate, slightly constricted at the septa, sparsely branched above the asci, hyaline, without gel coating, 3–4 μm wide (Fig. 5). Asci basal, fasciculate, fissitunicate, clavate to cymbiform, broad at the center and rounded towards the apex, 8-spored, 132–174 × 30–41 μm (mean = 160 × 35 μm, n = 15) with or without an apical chamber (Figs. 6, 7, 13). Ascospores 3–4 seriate, fusiform, multiguttulate, upper cell slightly broader than lower cell, 70–86 × 9–15 μm (mean = 76 × 12 μm, n = 50), one septate initially (Figs. 8–12) becoming three-septate with age (Fig. 9), slightly constricted at the septa, pale yellow brown becoming darker brown with age, with short, cellular, hyaline, tapering, apical appendages ca. 2–5 μm long (Fig. 8); ascospores surrounded by a large, fusiform, mucilaginous sheath (Figs.10, 11). Sheath at first appressed to the ascospore but elongating to form a sigmoid or C shape 200–452 long, 4–7 μm wide on either side of the ascospore at the midseptum, tapering towards the apices, surrounding the entire ascospore, expanding after ascospore is released from the ascus into the water; becoming extremely long and sticky after immersion in water (Fig. 10). Refractive acicular crystals formed within the ascospores and hyphae after preservation in lactic acid or glycerin (Figs. 12, 13).

Habitat: Saprobic on submerged wood in freshwater streams.

Geographical distribution: Costa Rica, Panama, USA (TN), Venezuela.

Etymology: "crystallinus" in reference to the refractive acicular crystals formed within the ascospores and hyphae after preservation in lactic acid or glycerin.

Holotype: USA. Tennessee: Great Smoky Mountains National Park, Elkmont Campground, a small stream between Jakes Creek and Little River, 35°39512'N, 83°34881'W, water temperature 23 C, pH 5, on submerged, decorticated wood, 5 July 2002, *Huzefa A. Raja & Nate Hamburger*, R076-1. (ILL).

Additional Specimens examined: COSTA RICA. Salto, La Selva Biological Station, 10°25'28N, 84°0'17W, water temperature 25 C, pH 7, on submerged decorticated wood, 18 May 2000, *Jennifer L. Anderson & Rebecca Wulffen*, A514-1; Arboleda Bridge, freshwater stream, 10°25'48N, 84°0'34W, water temperature 25 C, pH 6, on submerged monocotyledonous debris, 20 May 2000, *Jennifer L. Anderson & Rebecca Wulffen*, A514-6; Arboleda 30, freshwater stream, 10°25'47N, 84°0'39W, water temperature 26 C, pH 7, on submerged decorticated wood, 17 May 2000, *Jennifer L. Anderson & Rebecca Wulffen*, A514-2. PANAMA. Colon Province, Soberania National Park, Frijoles River, 9°08'0N, 79°43'0W, on submerged decorticated wood, 12 January 2003, *Astrid Ferrer* AF-007-1; Juan Grande River, on submerged corticated wood, 12 January 2003 *Astrid Ferrer* AF-007-2; Limbo River, 9°09'0N, 79°44'0W, on submerged corticated wood, 18 May 2003, *Astrid Ferrer* AF-007-3. USA, Tennessee. Outskirts of the Great Smoky Mountains

[6–13. *Aliquandostipite crystallinus*. 6. Asci. 7. Dehisced asci and acicular crystals in ascospores. 8. Ascospore showing sheath, arrow indicates the tapering apical appendages. 9. Three-septate ascospores. 10. Ascospore showing sheath extending in water, arrow indicates debris adhering to the sticky sheath. 11. Ascospore with fusiform, sigmoid sheath. 12–13. Ascospore and ascus showing acicular crystals after storage in lactic acid and glycerin. Measure bars for Figs. 6, 7, 8, 9, 11, 12, 13 = 10 μm. Fig. 10 = 20 μm. Figs. 6, 8, 9 (AF007). Fig 7 (A514-7). Figs. 10, 11, 12, 13 (R076-1).

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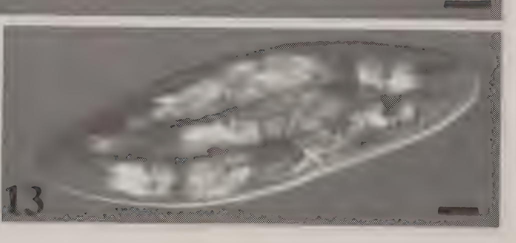
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National Park, Chilhowee Lake, 35°32'45N, 83°59'32W, water temperature 34 C, pH 5, submerged decorticated wood, 19 July 2000, *Jinx Campbell*, A514-3, VENEZUELA, Estado Portuguesa, mountain stream 2 miles from La Estacion, water temperature 28 C, pH 6, on submerged monocotyledonous debris, 16 January 1993, *J. L. Crane, J. D. Schoknecht & Francisco Ortega*, A514-7.

Comments: The genus *Aliquandostipite* was established by Inderbitzin et al. (2001) for an unusual ascomycete found on decaying wood in a rain forest in Thailand. This fungus produces dimorphic ascomata, i. e., sessile and stalked, and unusually large hyphae up to 50 μm wide. Inderbitzin et al. (2001) described two species, *Aliquandostipite khaoyaiensis*, the holotype of the genus, and *A. sunyatsenii* Inderb. Recently, Pang et al. (2002) transferred *A. sunyatsenii* to the genus *Jahnula* Kirschst. based on molecular phylogenetic analyses of 18S rDNA data.

The general characteristics of *A. crystallinus* fit within the generic concept of *Aliquandostipite. Aliquandostipite crystallinus* however, differs from *A. khaoyaiensis* in several ways. The ascomata of *A. khaoyaiensis* are sessile or stalked, whereas, in *A. crystallinus* only sessile ascomata have been observed in collections from four different geographical locations. The ascospores of *A. khaoyaiensis* are more rounded towards the apex and are shorter (49.6–70 × 12.8–20 μm) (Inderbitzin et al. 2001), whereas, the ascospores of *A. crystallinus* are more tapered and longer (70–86 × 9–15 μm). The gelatinous sheath around the ascospore, a feature common to both species, also varies. The sheath is rounded and balloon shaped in *A. khaoyaiensis*, (Fig. 18) whereas in *A. crystallinus* the sheath is sigmoidal or C-shaped and tapering towards the apices (Fig. 11). The ascospores of *A. crystallinus* possess a short, cellular, hyaline, tapering apical appendage at each ascospore apex (Fig. 8) and refractive acicular crystals form within the ascospores and hyphae after preservation in lactic acid or glycerin (Figs. 12–13). These characters are not found in *A. khaoyaiensis*. Considerable variation in the mean lengths and widths of ascospores and asci was observed among the populations of *A. crystallinus*. Costa Rica: ascospores = 75 × 18 μm, asci = 225 ×44 μm; USA (TN) ascospores = 76.5 × 12 μm, asci = 160 × 35 μm; Panama: ascospores = 69 × 13 μm, asci = 209 × 42 μm; Venezuela: ascospores = 80 × 19 μm, asci = 233 × 48 μm. These differences may be due to variation among specimens from different geographical locations.

The manner in which the ascospore sheath of *A. crystallinus* expands (Fig. 10) superficially resembles that of the ascospore sheath found in *Massarina ingoldiana* Shearer & K. D. Hyde (Shearer and Hyde 1997), and *Phaeosphaeria vilasensis* Fallah, Shearer & Leuchtm. (Fallah et al. 1999). All the aforementioned species belong to the loculoascomycetes, are found in freshwater habitats, and produce ascospore sheaths that extend upon contact with water. The presence of an ascospore sheath is considered to be an adaptation to the aquatic habitat, better enabling the ascospores to attach to substrates in water (Shearer 1993).

Ascospores of *Massarina lunispora* K. D. Hyde & Goh are surrounded by a C-shaped sheath and have short (2 μm long) cellular spines (Hyde and Goh 1998) similar to those of *A. crystallinus*. However, *A. crystallinus* differs from *M. lunispora* in ascomal color and wall structure, absence of a clypeus, and in the ascus and ascospore dimensions (larger asci and ascospores in *A. crystallinus*).

Aliquandostipite khaoyaiensis Inderb. American Journal of Botany 88: 54. 2001
Figs. 14–18

Ascomata globose to oval, tapering towards the peduncle (mean = 319 × 232 μm, n = 10, ascomal stalk 41–50 μm wide (Figs. 14, 15). Papilla ca. 50 μm high and 110 μm wide. Peridial wall made of large, 6–10 μm, thin-walled hyaline cells 13–19 μm wide (Fig. 16). **Asci** (mean = 179 × 44 μm, n = 20), clavate, with a small stalk (Fig. 17). Ascospores 2–3 seriate, oval in outline, multiguttulate, one-septate, slightly constricted at the septum, pale brown, upper cell broader than the lower cell (mean = 77 × 17 μm, n = 20), surrounded by a balloon shaped sheath (Fig. 18).

Habitat: Saprobic on decaying wood in a rain forest and on submerged wood in freshwater streams.

Geographical distribution: Costa Rica, Thailand.

Specimens examined: COSTA RICA. Sura 60, La Selva Biological Station, 10°25'48N, 84°1'32W, water temperature 25 C, pH 5, on submerged decorticated wood, 18 May 2000, *Jennifer L. Anderson & Rebecca Wulffen*, A441-1; **Panteno,** 10°25'8N, 84°0'22W, water temperature 25 C, pH 5.5, on submerged decorticated wood, 19 May 2000, *Jennifer L. Anderson & Rebecca Wulffen*, A441-2.

Comments: Collections of *Aliquandostipite khaoyaiensis* from freshwater in Costa Rica agree with the original protologue of *A. khaoyaiensis* from Thailand. Measurements of all the morphological features are within the range of those found in the type specimen collected from Thailand, except those of the asci and ascospores. The asci and ascospores of *A. khaoyaiensis* from Costa Rica are longer than those found by Inderbitzin et al. (2001). The mean of asci and ascospores for *A. khaoyaiensis* from Costa Rica are 179 × 44 μm and 77 × 17 μm respectively, whereas the mean of asci and ascospores from the type material are 166.67 × 45.57 μm and 61.80 × 16.27 μm. *Aliquandostipite khaoyaiensis* is reported for the first time from the Western Hemisphere from wood submerged in freshwater.

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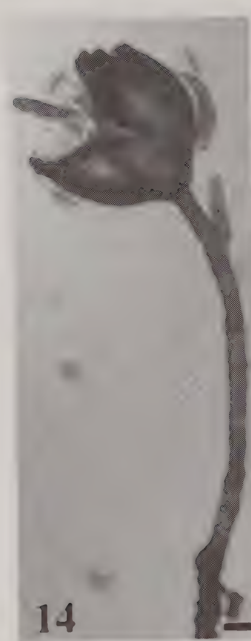
We would like to thank Prof. Margaret Barr and Dr. Sabine Huhndorf for reviewing the manuscript prior to submission. Appreciation is expressed to the GSMNP for permission to collect within the Park and La Selva Biological station and Dr. C. Pringle to collect in La Selva, Costa Rica. Financial support by the ATBI, DLIA (Grant No. DLIA 2002-12), the National Science Foundation (NSF Grant No. DEB 92-00885, DEB 95-08992 and DEB 99-71645, DEB 0316496), and National Institutes of Health (NIH Grant No. R01GM-60600) is gratefully acknowledged. We would like to thank J. L. Anderson, F. Ortega, J. Campbell, J. L. Crane, N. Hamburger, J. D. Schoknecht, and R. Wulffen for assistance with collecting. Thanks to C. Brown for helping with the measurements. Our thanks also go to Dr. Feng Sheng Hu and Ben Clegg, Department of Plant Biology, UIUC for allowing us access to their stereo microscope compatible camera. Thanks to Dr. J. Campbell for helping with the Latin description.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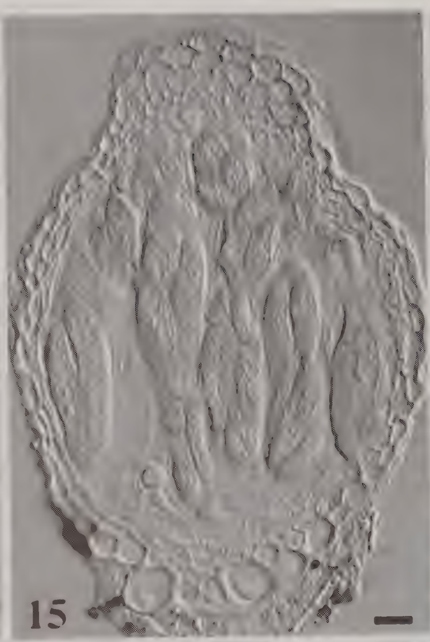
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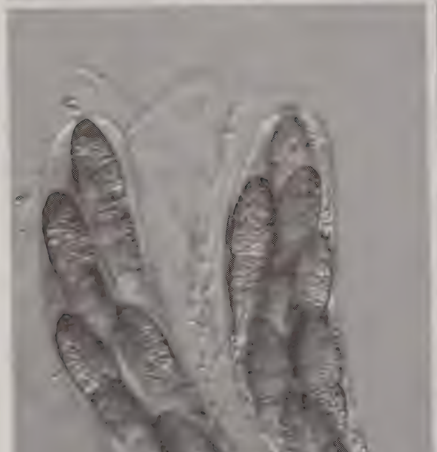
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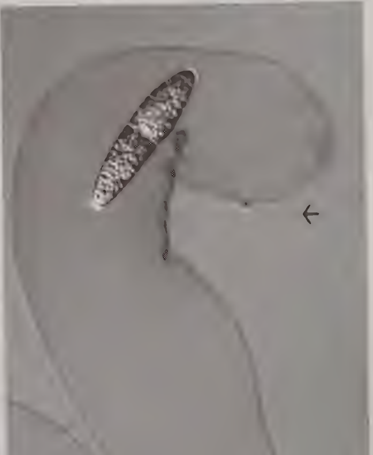
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Figs. 14–18. *Aliquandostipite khaoyaiensis*. (A441-1,-2). 14. Stalked ascoma. 15. Longitudinal section of ascoma. 16. Longitudinal section of peridial wall. 17. Asci and pseudoparaphyses. 18. Ascospores showing balloon shaped sheath (stained with India ink). Measure bars for Fig. 14 = 40 μm. Figs. 15, 17, 18 = 20 μm. Fig. 16 = 10 μm.

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Taxonomic studies on Ustilaginomycetes - 25

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Abstract—Twelve new species of smut fungi are described: *Anthracoidea blanda, Entyloma bergeniae, Macalpinomyces panici, Sporisorium panicicola, S. panici-fasciculati, S. panici-hirticaulis, Tilletia lolioli, T. mexicana, Urocystis beckwithiae, Ustilago ignota, U. perirregularis* and *U. tridentis*. New name: *Tilletia puneana*. New combinations proposed: *Cintractia eleocharidis, Jamesdicksonia linearis, Microbotryum primulae, Mycosyrinx usambarensis, Sporisorium andropogonis-schirensis, S. dietelianum, S. hodsonii, S. nyasalandicum, S. pseudomaranguense, S. scheffleri, S. tanganyikeanum, S. ugandense*. Nine taxa are placed in synonymy: *Crozalsiella argentina, Sphacelotheca dolichosora, S. panici-racemosi, Ustilago anhweiana, U. ehrhartana, U. enteropogonis, U. hypodytes* var. *congoensis, U. reticulispora* and *U. versatilis*. Lectotype is designated for *Sphacelotheca echinata* and *U. vesiculosa*. Neotype is designated for *Sporisorium panici-petrosi* and *Tilletia bromi*. Keys are given to the smut fungi of *Panicum, Tridens, Tripsacinae* and to the *Entyloma* spp. of *Saxifragaceae*.

Key words—taxonomy, pathogenic fungi

The smut fungi of *Panicum* (*Poaceae*)

Panicum L., in the subfamily *Panicoideae*, tribe *Paniceae*, subtribe *Setariinae*, is a large genus of about 470 species with fairly uniform spikelets but much variation in the habit. It is pantropical extending to temperate regions of N. America, in deserts, savannas, forests and swamps (Clayton and Renvoize, 1986:273). It is only natural that a great number of smut fungi have been described on *Panicum*. However, the taxonomy of both the host plants and their parasites has changed much during the last century, and many *Panicum* species are no longer in this genus.

Types of several smut fungi described as on *Panicum*, today belong to the host genera ***Brachiaria*** (*Sporisorium ovarium* (Griff.) Vánky; *Ustilago operta* Syd., P. Syd. & Butler), to ***Dichanthelium*** (*Sporisorium veracruzianum* (Zundel & Dunlap) M. Piepenbr.), to ***Digitaria*** (*Sporisorium diplosporum* (Ellis & Everh.) Vánky; *Ustilago cacheutensis* Speg.), to ***Echinochloa*** (*Moesziomyces bullatus* (J. Schröt.) Vánky; *Tolyposporium minus* J. Schröt.; *U. paradoxa* Syd., P. Syd. & Butler; *U. trichophora* (Link) Körn.), to ***Paspalidium*** (*Sporisorium panici* (E. MacKinnon) Vánky; *Ustilago panici-gracilis* E. MacKinnon; *U. rickeri* G.P. Clinton), to ***Pseudoraphis*** (*Sporisorium chameraphis* (Syd.) Vánky), to ***Sacciolepis*** (*Sporisorium manilense* (Syd. & P.

Syd.) Vánky), to ***Trichachne*** (*Sporisorium panici-leucophaei* (Bref.) M. Piepenbr.), to ***Tricholaena*** (*Sphacelotheca panici-teneriffae* Picb.; *Sporisorium tricholaenae* (Henn.) Vánky), or to ***Urochloa*** (*Macalpinomyces pretoriensis* (Pole-Evans) Vánky; *Sporisorium africanum* (Syd. & P. Syd.) Vánky).

In some cases, the host plants of new species were wrongly identified and later it turned out that they are ***Panicum*** spp. Ling (1951b:107) demonstrated that the host plants of the types of ***Sorosporium hodsonii*** Zundel (1930:152), of ***S. harrismithense*** Zundel (1930:154), and of ***S. flanaganianum*** Zundel (1930:155) are not „*Andropogon*" species but for the first two smuts they are *Panicum* species, for the third smut it is *Panicum laevifolium* Hackel. The host plant of ***S. argentinum*** Speg. is not „*Tricholaena insularis* (L.) Griseb." but *Panicum urvilleanum* Kunth (Spegazzini, 1925:151), and that of ***S. turneri*** McAlpine is not „*Eragrostis nigra* Nees var. *trachycarpa*" but *Panicum* cf. *effusum* R. Br. (teste L.A.S. Johnson, in herb.). The host of the type of ***Ustilago scheffleri*** Syd. & P. Syd. is not „*Pennisetum inclusum* Pilger" but *Panicum coloratum* L. (det. H. Scholz, sec. Vánky, 2003a:19), and that of ***Ustilago amadelpha*** Syd., P. Syd. & Butler var. ***glabriuscula*** Cif. is not „*Andropogon*" but *Panicum repens* L., and the smut is ***Sporisorium formosanum*** (Sawada) Vánky (Ling, 1949a:132; Rifai, 1980:399).

In other cases, the host has been misidentified as a *Panicum* sp. For example, the host of ***Sorosporium yoshinagae*** Zundel is *Ischaemum* sp. not „*Panicum repens* L." (Vánky, 2004a:98); that of ***Ustilago cordobensis*** Speg. is *Trichachne insularis* (L.) Nees not „*Panicum jaboncillo* Hieron." (Spegazzini, 1909:288); that of ***Sphacelotheca diplospora*** (Ellis & Everh.) G.P. Clinton var. ***glabra*** G.P. Clinton & Ricker is *Mesosetum* sp. not „*Panicum rottboellioides* Kunth" (Piepenbring, 2003:111), and that of ***Ustilago ugandensis*** Henn. is not „*Panicum* sp." but *Digitaria abyssinica* (A. Rich.) Stapf (Vánky, in this paper).

In several cases the fungus is not a smut, e.g. ***Tolyposporium reticulatum*** Speg. (type on *Panicum* sp., Uruguay) is *Ustilaginoidea reticulata* (Speg.) Zundel (1953:132). ***Ustilago braziliensis*** Zundel (type on *Panicum rivulare* Trin., Brazil) „is most probably an imperfect fungus" (Piepenbring, 2003:265). ***Ustilagopsis bertoniensis*** Speg. (type on *Panicum grumosum* aff., Paraguay) is a *Cerebella* sp. (Langdon, 1953:75).

An invalidly published taxon is ***Ustilago hypodytes*** (Schltdl.) Fries var. ***congoensis*** Zambettakis, 1979(1980):412 (no Latin diagn.), on *Panicum* sp.

Of the *Tilletia* species described on *Panicum, T. destruens* (Schltdl.) Lév. is *Sporisorium destruens* (Schltdl.) Vánky, *T. ayresii* Berk. and *T. heterospora* (Henn.) Zundel are *Conidiosporomyces ayresii* (Berk.) Vánky. *T. rotundata* (Arthur) Ellis & Everh. is a synonym of *T. maclaganii* (Berk.) G.P. Clinton, and *T. panici* Mundkur is a synonym of *T. vittata* (Berk.) Mundkur.

The 41 recognised smut fungi of *Panicum,* including seven new species, are:

1. *Conidiosporomyces ayresii* (Berk.) Vánky, in Vánky & Bauer, 1992:429.

Type on *Panicum maximum*, Mauritius, hills above Port Louis, P.B. Ayres 4754, K (Herb. Berkeley).

For synonyms, description and illustrations see Vánky & Bauer, 1992.

On *Panicum maximum* Jacq., *P. megastachyum* Nees, *P. parvifolium* Lam., *P. schinzii* Hack. (*P. laevifolium* Hack.), *Setaria paniculifera* (Steudel) Fourn. (*Panicum paniculiferum* Steudel), *S. pumila* (Poir.) Roem. & Schult. (*S. pallide-fusca*

(Schumacher) Stapf & C.E. Hubb. ex Moss), *S. sphacelata* (Schumacher) Moss var. *aurea* (A. Br.) W.D. Clayton (*S. aurea* A. Br.). Widespread, in the tropics of Africa, Asia and America.

2. *Eballistra brachiariae* (Viégas) R. Bauer, Begerow, A. Nagler & Oberwinkler, 2001:423.

Melanotaenium brachiariae Viégas, 1944:748. — Type on *Brachiaria plantaginea*, Brazil, Est. de Sao Paulo, Mogí-Mirim, Faz. Emílio Spina, 27.II.1941, A.P. Viégas, IACM; isotypes HCIO 11662, HUV 15410!

Tolyposporella brachiariae Mundkur & Thirumalachar, 1946:5. — Type on *Brachiaria distachya*, India, Mysore, Bangalore, 14.II.1942, M.J. Thirumalachar, HCIO 10339-10341; isotypes IMI, HUV 17328. (syn. by Vánky, 1997:139).

Melanotaenium echinochloae M.S. Patil, 1992:180. — Type on *Echinochloa* sp. (= misnamed *Brachiaria distachya*, teste Vánky, 1997:139), India, Maharashtra State, Kolhapur, Shivaji University Campus, 8.X.1978, M.S. Patil, HCIO 30109; isotype HUV 15494! (syn. by Vánky, 1997:139).

Melanotaenium urochloae M.S. Patil, 1992:180. — Type on *Urochloa trichopus* (= *U. panicoides*, teste Vánky), India, Maharashtra State, Kolhapur, 19.XII.1979, A.R. Kulkarni, HCIO 30110; isotype HUV 17509. (syn. by Vánky, 2004a:86).

Sori on the leaves, leaf sheaths, stems and also on the floral axis and branches, first as yellowish-green, later lead coloured, nonerumpent spots, on the leaves linear or by coalescence fusiform or irregular, sometimes covering nearly the whole leaf blade, 0.3-5 x 1-20(-30) mm, on the stems up to 80 mm long. *Spores* embedded in the host tissues, crowded, often in irregular groups or rows; single spores ovoid, ellipsoidal, usually irregularly subpolyhedral, (6.5-)7-12 x 8-14(-16) μm, dark reddish-brown; wall uneven, thickest at the angles, 1-3 μm wide, smooth. *Spore germination* results in holobasidia on which apically, passively released basidiospores are produced (Singh & Pavgi, 1973).

On *Brachiaria distachya* (L.) Stapf, *B. piligera* (F. Muell. ex Benth) Hughes (*Urochloa piligera* (F. Muell. ex Benth) R. Webster), *B. plantaginea* (Link) Hitchc., *Panicum coloratum* L., *Urochloa panicoides* P. Beauv., *U. trichopus* (Hochst.) Stapf; Africa (Zambia, Zimbabwe), Asia, Australia, S. America (Brazil).

E. brachiariae was only recently discovered on *Panicum*, in Zambia, 29.IV.2001, C. & K. Vánky (HUV 19720).

3. *Macalpinomyces panici* Vánky, **sp. nov.**

Typus in matrice *Panicum aequinerve* Nees, South Africa, KwaZulu-Natal Prov., Royal Natal National Park, 1.5 km from the visitor centre towards the "amphitheatre", 28°41'41" S, 28°56'58" E, alt. cca. 1510 m.s.m., 29.XII.1996, leg. C. & K. Vánky, HUV 20616; isotypi in Vánky, Ust. exs. no. 1237. Paratypus: KwaZulu-Natal Prov., Drakensberg Mts., Loteni Nature Reserve, 29°26'16" S, 29°31'02" E, alt. cca. 1610 m.s.m., 6.I.1997, leg. C. & K. Vánky, HUV 20617; isoparatypus in PREM.

Sori in flore supremo fertili spiculorum omnium eiusdem inflorescentiae, globoidei, 1-1,5 mm in diametro, cum apice uno, cca. 1 mm longo, acuto, e residuis involucrorum floralium internorum constituto, plus-minus glumis intactis obtecti, primo peridio tenui, cinerescenti epidermidis plantae nutrientis cooperti, quo irregulariter rupto massam atrobrunneam, semiagglutinatam usque pulveream sporarum et catervarum cellularum sterilium, per columellam brevem, obtusam, latam, centralem productarum ostendentes.

> *Sporae* globosae, subglobosae, ovoideae, plerumque ellipsoidales, 8-10,5 x 9,5-12(-13) μm, flavidobrunneae; pariete aequali, cca. 1 μm crasso, moderate dense, humiliter echinulato, imago obliqua sporarum leniter serrulata. *Cellulae steriles* in catervis laxis, irregularibus, cellulae singulae globoideae, ellipsoidales usque parum irregulares, 5,5-10,5 x 6,5-11 μm, hyalinae, cum guttulis 1-3 oleaginis(?) instructae; pariete aequali, cca. 0,8 μm crasso, levi.

Sori (Fig. 1) in the upper, fertile flower of all spikelets of an inflorescence, globoid, 1-1.5 mm in diameter, with a c. 1 mm long, acute tip, consisting of remnants of the inner floral envelopes, more or less hidden by the intact glumes, first covered by a thin, greyish peridium of host epidermis which ruptures irregularly disclosing the dark brown, semiagglutinated to powdery mass of spores and groups of sterile cells produced by a short, blunt, wide, central columella. *Spores* (Figs. 4, 5) globose, subglobose, ovoid, mostly ellipsoidal, 8-10.5 x 9.5-12(-13) μm, yellowish-brown; wall even, c. 1 μm thick, moderately densely, low echinulate, spore profile finely serrulate. *Sterile cells* (Figs. 4, 5) in loose, irregular groups, single cells globoid, ellipsoidal to slightly irregular, 5.5-10.5 x 6.5-11 μm, hyaline, with 1-3 oil(?) droplets; wall even, c. 0.8 μm thick, smooth.

On *Panicum aequinerve* Nees. Known only from the two type collections.

4. *Macalpinomyces pretoriensis* (Pole-Evans) Vánky, 2003a:57.

Ustilago pretoriensis Pole-Evans, in Sydow, H. & P., 1914:263. — *Sphacelotheca pretoriensis* (Pole-Evans) Zundel, 1938:301. — *Sporisorium pretoriense* (Pole-Evans) Vánky, 1998a, nom. herb. — Type on *Panicum helopus* var. *glabrescens* (= *Urochloa panicoides*), South Africa, Transvaal, Pretoria, 20.III.1914, A.O.D. Mogg, PREM 7408; isotype HUV 18004!

Sori in some flowers of an inflorescence transforming the inner floral organs into one or several, horn-shaped, cylindrical or twisted bodies, 0.3-2.5 x 5-40 mm, first covered by a greyish-brown peridium which shreds into numerous, long filaments disclosing the semiagglutinated to powdery mass of spores and sterile cells. *Spores* single when mature, globose, subglobose to broadly ellipsoidal, 9-12.5 x 9.5-13 μm, yellowish-brown; wall even, c. 1 μm thick, prominently, moderately densely echinulate, spore profile serrulate. *Sterile cells* in irregular groups, single cells subglobose, ovoid, ellipsoidal or subpolyhedrally slightly irregular, smaller than the spores, 5-8 x 6-11 μm, hyaline; wall c. 0.5 μm thick, smooth, content homogeneous.

On *Panicum maximum* Jacq., *Urochloa panicoides* P. Beauv. (*U. helopus* (Trin.) Stapf; *Panicum helopus* Trin. var. *glabrescens* (K. Schum.) Stapf), *U. trichopus* (Hohst.) Stapf; Africa (South Africa, Zambia, Zimbabwe).

5. *Macalpinomyces sharmae* Vánky, 1995:223.

Type on *Panicum sumatrense*, India, Madhya Pradesh, 35 km E. of Jabalpur, 11.X.1992, N.D. Sharma, S.R. Singh, M.B. Nagar, S. Nema, C. & K. Vánky, HUV 16017!; isotype BPI 802367. Paratypes: India, M.P., Dindori, Mandla, 3.IX.1984, N.D. Sharma, HUV 16054!; M.P., Rewa, 16.IX.1991, A.K. Jain, HUV 16055!; Rewa, 26.IX.1991, N.D. Sharma, HUV 16013!; Rewa, 20.IX.1992, A.K. Jain, HUV 16056! Paratype on *Setaria pallide-fusca* (= *S. pumila*), India, Madhya Pradesh, 52 km E of Jabalpur, alt. c. 580 m, 11.X.1992, N.D. Sharma, S.R. Singh, M.B. Nagar, S. Nema, C. & K. Vánky; HUV 16053!

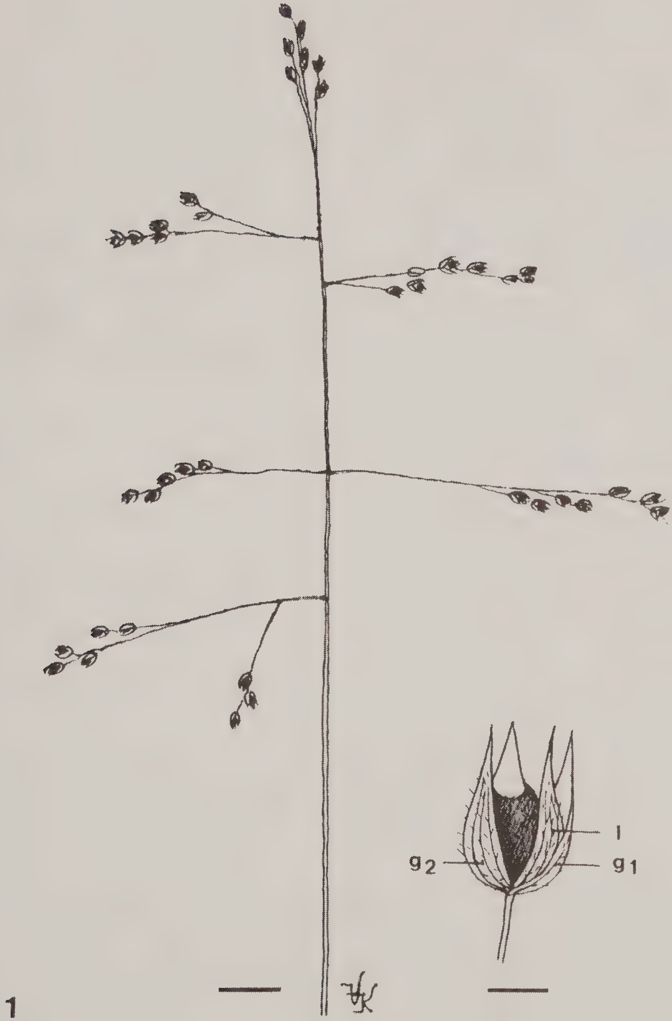

Fig. 1. Sori of *Macalpinomyces panici* in all fertile florets of *Panicum aequinerve* (type). Habit, and enlarged a spikelet with a sorus (g_1 = first glume, g_2 = second glume, l = lemma of the sterile floret). Bars = 1 cm for habit, and 1 mm for the detail drawing.

Sori in some ovaries of an inflorescence, inconspicuous, hidden by the floral envelopes, ovoid, 0.8-1 x 2 mm, covered by a relatively thick, light to dark brown peridium which ruptures irregularly to expose the blackish-brown, granular mass of spores intermixed with sterile cells. Peridium composed of an external layer of host origin (pericarp) and a thick, internal layer of fungus origin, in which the spores differentiate; fungal cells between the spores are transformed into sterile cells. *Spores* agglutinated in irregular groups. Single spores subglobose, ovoid, usually subpolyhedrally irregular, 6.5-9 x 7-10.5(-11) μm, yellowish-brown; wall thin, c. 0.5 μm, finely and densely punctate-verruculose, spore profile smooth to finely wavy. *Sterile cells* subglobose, ovoid to slightly irregular, larger than the spores, 9-12 x 11-17 μm, single or in loose groups, subhyaline to light yellowish-brown; wall c. 1 μm thick, smooth. *Spore germination* results in one or two septate basidia measuring 2-3.5 x 17-35 μm, on which laterally and terminally basidiospores are produced. Basidiospores ovoid to long ellipsoidal, 1.5-2.5 x 3-8 μm, hyaline, germinating like yeasts (Vánky, 1995:223, figs. 14-15).

On *Panicum sumatrense* Roth ex Roem. & Schult. (*P. miliare* Lam.), *Setaria pumila* (Poir.) Roem. & Schult. (*S. pallide-fusca* (Schumacher) Stapf & C.E. Hubb. ex Moss), *S. surgens* Stapf; S. Asia (India), Australia.

6. ***Macalpinomyces spermophorus*** (Berk. & M.A. Curtis ex de Toni) Vánky, 2003b:210.

Ustilago spermophora Berk. & M.A. Curtis ex de Toni, in Saccardo, 1888:466. — *Ustilago spermophora* Berk. & M.A. Curtis, in Curtis, 1867:123 (as "*spermophorus*"; nom. nud.). — *Sphacelotheca spermophora* (Berk. & M.A. Curtis ex de Toni) Moesz, 1921:63. — Type on *Eragrostis poaeoides* P. Beauv. var. *megastachya* Koehler (= *Eragrostis cilianenis* (All.) Janchen), USA, Iowa, Charles City, September 1882, J.C. Arthur; isotypes in Ellis, N. Amer. fgi. no. 1098, as *Ustilago spermophorus*, HUV 10545!

Ustilago boutelouae Kellerman & Swingle, 1889:13. — Type on *Bouteloua oligostachya* Torr. (= *B. gracilis* (H.B.K.) Lag. ex Steudel), USA, Kansas, Autumn & Winter 1888. (syn. by Vánky, 2004b:168).

Ustilago kusanoana Hennings, 1904:140. — *Sphacelotheca kusanoana* (Henn.) Hennings, 1905:594. — *Cintractia kusanoana* (Henn.) Shirai, 1905:20. — Type on *Eragrostis ferruginea* P. Beauv., Japan, Tokyo, IX.1901, S. Kusano 350, S! (syn. in Zundel, 1953: 203, confirmed).

Ustilago ugandensis Henn. var. *macrospora* Beeli, 1922:6. — Lectotype on *Panicum* sp., Congo, (design. by Vánky, 2004a:115) Leopoldville Prov., Kisantu, VII.1914, H. Vanderyst 4657, BR 1318, isolectotype BPI 194482! (syn. by Vánky, 2004a:115).

Ustilago orientalis W.Y. Yen, 1935:7 (nom. illeg., no Latin diagnosis). — *Ustilago spermophora* Berk. & Curt. var. *orientalis* (W.Y. Yen) W.Y. Yen, 1937:187 (comb. illeg.). — On *Eragrostis cilianensis* (All.) Lutati, China, Nanking, near Lingkutze, IX.1930, T.N. Liou, PC! (syn. by Ling, 1953b:324, confirmed).

Ustilago eragrostidis-japonicana Zundel, 1943:165. — Type on *Eragrostis japonica* Trin., South Africa, Cape Prov., Vryburg Distr., Welgelegen, IV.1925, G.A. Pentz, PREM 20621!; isotypes BPI 160370, 188933 (syn. by Vánky, 2004a:115).

Sphacelotheca cheoana Zundel, 1943:168. — Type on *Eragrostis cilianensis* (All.)

Lutati, China, Anhwei Prov., Chu Hua Shan, Ch'ing Yang Hsien, Sha Kan, 24.X.1932, S.Y. Cheo 1395, BPI 177306! (syn. by Vánky, 1990:273).

Ustilago spermophoroides Y. Ling & Chen, 1945:5. — Type on *Eragrostis japonica* (Thunb.) Trin., China, Fukien, Shahsien, 10.X.1942, T.L. Chen 301. (syn. by Ling, 1953b:324).

Ustilago convertere-sexualis Durán, 1987:228. — Type on *Cathestecum prostratum* Presl, Mexico, Puebla, 3.2 km S of Tehuitzingo, hwy no. 190, alt. 1371 m, 16.IX.1976, R. Durán & P.M. Gray, WSP 67752! (syn. by Vánky, 2004b:170).

Ustilago pueblaensis Durán, 1987:243. — Type on *Cathestecum prostratum* Presl, Mexico, Puebla, 3.2 km S of Tehuitzingo, hwy no. 190, alt. 1371 m, 16.XI.1976, R. Durán & P.M. Gray, WSP 67755! Paratype on *Cathestecum erectum* Vasey & Hack, Mexico, Puebla, 29.1 km NW of Tehuitzingo, hwy no 190, on the road to Oaxaco, alt. 1432 m, 16.XI.1976, R. Durán & P.M. Gray, WSP 68569; isoparatype HUV 14632! (syn. by Vánky, 2004b:170).

Sori in some ovaries of an inflorescence as first green, later brown, spherical or pyriform bodies showing between the glumes, 1-2 × 1-3(-4) mm, covered by a peridium of fungal and host origin which ruptures irregularly to expose the dark brown, powdery mass of spores intermixed with sterile cells. Often the distal part of the sorus bears a remnant of the caryopsis as a hard, yellowish-brown, acute body. Sori often fall off the plant. Heavily infected panicles may be congested. *Spores* globose, subglobose to ovoid, occasionally elongate or irregular, 6.5-9(-10) × 8-11(-13) μm, light brown; wall even, c. 0.5 μm thick, finely, moderately densely verrucose-echinulate, spore profile wavy to usually finely serrulate. *Sterile cells* globose, subglobose, ellipsoidal, rarely elongate, 5.5-8 x 6-11 μm, hyaline, collapsed in old specimens; wall thin, c. 0.5 μm, smooth. *Spore germination* of *Ustilago*-type (Kellerman & Swingle, 1889:13; Ito, 1936:17; Durán, 1987:229, 244).

On at least 14 species of *Eragrostis* (cosmopolitan), on *Bouteloua*, *Cathestecum* and *Hilaria* spp. (USA, Mexico), on *Panicum* sp. (Congo), and *Sporobolus australasicus* Domin (Australia).

7. ***Sporisorium cryptum*** (McAlpine) Vánky, 2000:173.

Ustilago crypta McAlpine, 1897:42. — *Sorosporium cryptum* (McAlpine) McAlpine, 1910:176. — Type on *Panicum bicolor* (= *P. bicoloratum*), Australia, New South Wales, 1896, Maiden, VPRI 2956.

Sorosporium turneri McAlpine, 1910:185. — Type on *Eragrostis nigra* Nees var. *trachycarpa* (= misnamed *Panicum* cf. *effusum*; teste L.A.S. Johnson, in herb.), Australia, New South Wales, New England, near Armidale, 8.XI.1906, F. Turner, VPRI. (syn. by R.F. Langdon, in herb.).

Sori in the spikelets infecting all in the inflorescence, leaving intact the outermost floral envelopes, ovoid to cylindrical, 0.5-1.5 x 1-15 mm (depending on the host species), first covered by a pale brown peridium which ruptures from its apex disclosing the dark brown, semiagglutinated to powdery mass of spore balls and spores surrounding a stout, simple, tapering columella. *Spore balls* variable in shape and size, globose, ellipsoidal, elongated or irregular, 30-100 x 40-160 μm, dark brown to opaque, composed of tens to hundreds of easily separating spores. *Spores* subglobose, subpolyhedrally irregular, mostly ellipsoidal, 6-9.5 x 8-10.5 μm, yellowish-brown; wall even, c. 0.8 μm, finely punctate to verruculose, spore profile smooth, in SEM finely verrucose-echinulate, the spores often appearing mamillate. *Sterile cells* not seen.

On *Brachiaria holosericea* (R. Br.) Hughes, *B. polyphylla* (R. Br.) Hughes, *Panicum bicoloratum* S.T. Blake (*P. bicolor* R. Br.), *P. effusum* R. Br., *P. effusum* R. Br. var. *simile* (Domin) B.K. Simon (*P. simile* Domin; *P. fulgidum* Hughes), *P. queenslandicum* Domin, *P. subxerophilum* Domin, *P. trachyrachis* Benth., *Yakirra pauciflora* (R. Br.) Lazarides & R.D. Webster (*Panicum pauciflorum* R. Br.); Australia.

8. *Sporisorium destruens* (Schltdl.) Vánky, 1985:115.

Caeoma destruens Schlechtendal, 1824:130. — *Uredo destruens* (Schltdl.) Duby, 1830:901. — *Tilletia destruens* (Schltdl.) Léveillé, 1847:372. — *Ustilago destruens* (Schltdl.) Rabenhorst, in Rbh., Herb. viv. myc., ed. 2, no. 400, 1857. — *Anthracocystis destruens* (Schltdl.) Brefeld, 1912:53. — *Sphacelotheca destruens* (Schltdl.) J.A. Stevenson & A.G. Johnson, 1944:613. — Neotype (design. by Vánky, 1985:116) on *Panicum miliaceum*, Germany, Bunzlau [= Poland, Bolesławiec], J. Kühn, HUV 1895!; isoneotypes in Rbh., Herb. viv. myc., ed. 2, no. 400 (as *Ustilago destruens*). The holotype was lost in Berlin during World War II. No isotypes are preserved in Herb. Schlechtendal (HAL) either.

Uredo segetum □ *Uredo Panici miliacei* Persoon, 1801:224. — *Uredo carbo* □ *panici-miliacei* (Pers.) De Candolle, 1815:76. — *Erysibe panicorum* Wallr. □ *panici-miliacei* (Pers.) Wallroth, 1833:216. — *Ustilago panici-miliacei* (Pers.) G. Winter, in Rabenhorst, 1881:89. — *Sorosporium panici-miliacei* (Pers.) Takahashi, 1902:184 & 247. — *Sphacelotheca panici-miliacei* (Pers.) Bubák, 1912:27. — Type on *Panicum miliaceum*, sine loco.

Sorosporium manchuricum S. Ito, 1935:93. — *Sphacelotheca manchurica* (S. Ito) Wang, 1962:134. — Type on *Panicum miliaceum*, Japan, Hokkaido, Ishikari Prov., Sapporo, 5.IX.1910, S. Hashimoto. (syn. by Ling, 1953b:329).

Sori comprising the whole, completely destroyed inflorescence, ovoid to elongate, 0.5-2 cm wide and 3-6 cm long, partly concealed by leaf sheaths and covered by a well developed, whitish peridium which ruptures irregularly and flakes away to expose the dark brown, dusty spore mass and numerous, long, filiform columellae composed of host tissues, mainly vascular bundles, and hyphae. *Spores* when young in irregular, loose spore balls, at maturity single, subglobose, ovoid to elongated or irregular, 7-9 x 8-13 μm, light reddish-brown, smooth; in SEM finely, densely verruculose. *Sterile cells* subhyaline or pale yellow, thin-walled, almost the size of the spores. *Spore germination* results in four-celled basidia. In water, basidial cells fuse and produce mycelia, in nutrient media abundant basidiospores are produced (Brefeld, 1883:97-101; Vasey, 1918:11). Infection systemic, initiated in seedling stage of the hosts.

On *Panicum capillare* L., *P. miliaceum* L. (cult.); Europe, S. Africa, Asia, Australia, N. America.

9. *Sporisorium formosanum* (Sawada) Vánky, 1983:12.

Ustilago formosana Sawada, 1918:6 (in Japanese; n. v.); in Tanaka, 1922:89. — *Sorosporium formosanum* (Sawada) Sawada, 1928:29 (n. v.). — Type on „*Panicum proliferum* Lam.“ (probably = *P. repens*; Vánky, 1994:202), Formosa [= Taiwan, N.R. China], no special collection designated.

Ustilago digitariae Rabenhorst f. *panici-repentis* J.G. Kühn, 1876:5, nom. confus. (comp. Vánky, 1990:274). — On *Panicum repens* L. & *Cynodon dactylon* (L.) Pers., Spain, Malaga, 16.X.1875, Walffenstein, HUV 10266!

Sorosporium panici Beeli, 1922:7 (later homonym, not MacKinnon, 1912:201). — *Sorosporium beeli* Zundel, 1938:307 (nom. nov. pro *Sorosporium panici* Beeli). — Type on *Panicum* sp. (= *P. repens*, teste Ling, 1951a:46), Congo, Leopoldsville prov., Boma, 1913, H. Vanderyst, BR 1315, HUV 19163. (syn. by Ling, 1951a:46).

Sorosporium panici Beeli var. *kinshasaensis* Beeli, 1922:8. — *Sorosporium kinshasaensis* (Beeli) Zundel, 1937:590. — Type on *Panicum kinshasaensis* Vanderyst (= *Panicum repens*), Congo, Kinshasa, 2.VI.1916, H. Vanderyst 4, BR 1323. (syn. by Ling, 1951a:46).

Ustilago overeemii Ciferri, 1933:254 (as „*overeeimi*"). — *Sorosporium overeemii* (Cif.) Malençon, 1945:121. — *Sporisorium overeemii* (Cif.) Rifai, 1980:400. — Type on *Panicum repens*, Indonesia, Java, Bogor, Botanical Garden, IV.1921, V. Overeem 633 (syn. by Ling, 1949b:266).

Ustilago amadelpha Syd., P. Syd. & Butler var. *glabriuscula* Ciferri, 1933:255. — Type on ?*Andropogon* (= misnamed *Panicum repens*, teste Rifai, 1980:399), Indonesia, Java, Bogor, Botanical Garden, IV.1931, K.B. Boedijn 12347, Hortus Bogor. no. 633. (syn. by Ling, 1949a:132).

Sorosporium punctatum Malençon & Yen, 1937:130. — Lectotype on *Panicum repens*, Morocco, Rabat, (design. by Vánky, 1994:202) 1.VI.1907, PC! (syn. by Ling, 1949b:266).

Sorosporium beeli Zundel var. *kinshasaensis* Hendrickx, 1948:8 (n.v.). — Type on *Panicum* sp., Congo. (syn. by Ling, 1951a:46).

Ustilago hypodytes (Schltdl.) Fries var. *congoensis* Zambettakis, 1979(1980):412 (invalidly published, no Latin diagn., ICBN 36.1). — On *Panicum* sp., Congo, Leopoldsville Prov., Atène, I.1914, H. Vanderyst 3439, HUV 17148! (syn. nov.).

Sori comprise the whole inflorescence and upper part of the culm, 2-9 cm long, up to 6 mm wide, partly enclosed by leaf sheaths, initially covered by a whitish- or greyish-brown fungal peridium which flakes away exposing the blackish-brown, granular-powdery mass of spore balls and numerous, long, filiform shreds. *Spore balls* globose, ovoid to elongate or irregular, 20-60 x 30-120 μm, composed of numerous spores which separate fairly easily. *Spores* globose to subpolyhedral, 5-6.5 x 5.5-7 μm, medium olivaceous-brown; wall even or slightly uneven, c. 0.5 μm thick, finely and sparsely punctate. *Sterile cells* of the peridium cylindrical, 3-5 x 6-15 μm, hyaline, arranged in long, parallel chains. *Germination* of *Ustilago* type.

On *Panicum repens* L.; Europe, Africa, Asia.

10. *Sporisorium hodsonii* (Zundel) Vánky, comb. nov.

Basionym: *Sorosporium hodsonii* Zundel, Mycologia 22:152, 1930. — Type on *Andropogon* sp. (= misnamed *Panicum* sp.; Ling, 1951b:107), South Africa, Transvaal, Hopefield, Lawley Post Office, 2.II.1910, G.B. Lawley, PREM 704; isotypes BPI 180035, 195137, HUV 17998!

Sorosporium harrismithense Zundel, 1930:154. — Type on *Andrpogon* sp. (= misnamed *Panicum laevifolium*; Ling, 1951b:107, = *P. schinzii*), South Africa, Orange

Free State, Harrismith, 22.II.1911, C.P. van der Merwe, PREM 1473; isotypes BPI 180017, 195140, HUV 17996! (syn. by Ling, 1951b:107, confirmed).

Sorosporium flanaganianum Zundel, 1930:155. — Lectotype on *Andropogon* sp. (= misnamed *Panicum* sp.; Ling, 1951b:108), South Africa, (designated by Zundel, 1938:309) Transvaal, Emmasdale, Heidelberg, 15.I.1910, without collector, PREM 713; isolectotype HUV 17994! Syntype: Cape Prov., Prospect, 21.I.1916, H. Flanagan, PREM 9423; isosyntype HUV 17995! (syn. by Ling, 1951b:107, confirmed).

Ustilago versatilis H. Sydow, 1935:231. — *Sorosporium versatile* (Syd.) Zundel, 1938:308 (as „*versatilis*"). — Type on *Panicum proliferum* var. *paludosum* (= *P. subalbidum*), South Africa, Eastern Cape Prov., Komga, Prospect, 12.II.1916 (as „12. II.1926"), H.G. Flanagan, PREM 9550; isotypes BPI 180825, HUV 18178! (syn. nov.).

Sorosporium afrum H. Sydow, 1935:232. — Type on *Panicum laevifolium* (= *P. schinzii*), South Africa, Transvaal, Johannesburg, III.1931, A.M. Bottomley, PREM 26608; isotype HUV 17983! (syn. by Ling, 1951b:107, confirmed).

Sori destroying the whole inflorescence, cylindrical or broadly fusiform, 0.3-1 x 1.5-4 cm, partly enclosed by the uppermost leaf sheath, first covered by a pale brown peridium which dehisces at maturity from its distal part, disclosing the dark brown, agglutinated to granular-powdery mass of spore balls and few sterile cells surrounding numerous filiform columellae. *Spore balls* globose, ellipsoidal, ovoid, elongated or slightly irregular, 35-90 x 45-120 μm, dark reddish-brown to subopaque, composed of tens of spores which separate easily by pressure. *Spores* subglobose, ovoid, broadly ellipsoidal to usually subpolyhedrally slightly irregular, 8-12 x 8.5-13(-14) μm, yellowish-brown with several, relatively large, slightly lighter areas; wall uneven, alternating c. 0.4-1 μm thick, thickest at the angles, surface finely, rather densely, uniformly verrucose-echinulate, spore profile wavy to finely serrulate. *Sterile cells* sparse, in small groups or single, 8-12 μm long, hyaline, collapsed in old specimen; wall thin, c. 0.5 μm, smooth.

On *Panicum capillare* L, *P. dichotomiflorum* Michaux, *P. subalbidum* Kunth (*P. longijubatum* Stapf; *P. proliferum* Lam. var. *paludosum* Stapf), *P. schinzii* Hack. (*P. laevifolium* Hack.), *P. virgatum* L., *Panicum* sp.; Africa (South Africa, Sudan), E. Asia (Japan)¸ N. America (Canada, Mexico, USA).

Probably also on *P. hirticaule* Presl, *P. miliaceum* L., *P. vaseyanum* Scribn.

The alternatively thicker and thinner spore wall, resulting in lighter coloured areas of the spores, is typical for *Sporisorium hodsonii*.

Ling (1951b:108) discussed the similarity and possible conspecificity of *Sorosporium hodsonii* and *S. versatilis*. I consider the morphological differences shown by Ling as variations within the same species.

11. *Sporisorium nyasalandicum* (L. Ling) Vánky, comb. nov.

Basionym: *Sorosporium nyasalandicum* L. Ling, Sydowia 7:156, 1953c. — Type on *Panicum* sp., Nyasaland [= Malawi], Palombe Plains, 20.VII.1951, G. Jackson, IMI 49707!

Sori destroying the innermost floral organs („ovaries"), inconspicuous, partially exposed between the glumes, ellipsoidal, 0.5-1 x 2-2.5 mm, first covered by a thin, pale brown peridium which later flakes away disclosing the blackish-brown, semiagglutinated to granular-powdery mass of spore balls surrounding a simple central columella. *Spore balls* variable in shape and size, subglobose, ovoid, ellipsoidal, elongated to subpolyhedrally irregular, rather persistent, 30-65 x 35-110 μm, dark reddish-brown to usually opaque, composed of a few to several tens of spores which separate by pressure. *Spores* subglobose, ellipsoidal to usually subpolyhedrally irregular, 8-11 x 8.5-14.5 μm, medium to deep reddish-brown; wall uneven, 0.5-1 μm thick, thickest at the angles, from apparently smooth to finely, densely punctate-verruculose, spore profile smooth, in SEM finely, uniformly, moderately densely verruculose. *Sterile cells* not seen.

On *Panicum* sp.; Africa (Malawi). Known only from the type collection.

12. *Sporisorium ovarium* (Griffiths) Vánky, 1997:138.

Sorosporium ovarium Griffiths, 1907:209. — Lectotype on *Panicum caespitosum* (= *Brachiaria reptans*), Mexico (designated by Zundel, 1953:68), Hidalgo, Dublan, 9.IX.1905, D. Griffiths, BPI 180088!

Sphacelotheca panici-racemosi Zillig, nom. herb.? — On *Panicum racemosum*, Uruguay, Dept. Montevideo, Pajas Blancas, IV.1935, Herter, BPI 194874, HUV 15924! (syn. nov.).

For taxonomic synonyms, such as *Sorosporium brachiariae*, *S. brachiariae-ramosae*, *Sphacelotheca diplospora* var. *verruculosa*, *Ustilago verecunda*, *U. urochloana*, their nomenclatural synonyms, literature and host plants see Vánky, 2004a:87.

Sori in the flowers ("ovaries") of all spikelets of an inflorescence, more or less hidden by the floral envelopes, subcylindrical or with subacute tips, 1-1.5 x 2-3.5 mm, first covered by a light brown, leathery peridium which ruptures irregularly from its apex exposing the chocolate-brown, semipowdery mass of spore balls and a columella with short branches or 2-3, short, filiform columellae. *Spore balls* loose, with many spores, 35-100 x 45-130 μm or larger, reddish-brown. *Spores* subglobose, ovoid, broadly ellipsoidal or irregularly subpolyhedral, 8-10.5 x 8.5-11(-12) μm, yellowish- to reddish-brown; wall even, c. 0.8 μm thick, densely, uniformly, finely echinulate causing the spore edge to appear finely serrulate. *Sterile cells* few, in small, irregular groups, in short chains or single, globose, ellipsoidal, flattened on contact sides, 9-18 μm long, hyaline, content granular, wall 1-1.5 μm thick, smooth. In some collections sterile cells are apparently lacking.

On *Brachiaria brizantha* (A. Rich.) Stapf, *B. lata* (Schum.) C.E. Hubb., *B. meziana* Hitchc., *B. piligera* (F. Muell.) Hughes, *B. ramosa* Stapf, *B. reptans* (L.) C.A. Gardner & C.E. Hubb. (*Panicum reptans* L.; *Urochloa reptans* (L.) Stapf; *P. caespitosum* Sw.), *B. xantholeuca* (Hackel ex Schinz) Stapf, *Panicum maximum* Jacq., *P. racemosum* (P. Beauv.) Sprengel, *Urochloa fasciculata* (Sw.) R. Webster, *U. mosambicensis* (Hack.) Dandy (*U. pullulans* Stapf var. *mosambicensis* Hackel), *U. panicoides* P. Beauv. (*U. helopus* (Trin.) Stapf), *U. trichopus* (Hochst.) Stapf, *Urochloa* sp. Widespread (Africa, Asia, Australia, N., C. & S. America).

The spores of "*Sphacelotheca*" *panici-racemosi* (HUV 15924) differ from those of typical *Sporisorium ovarium* in having finer spore ornamentation; in LM apparently smooth to very finely punctate, spore profile smooth, in SEM very finely, densely verruculose. In other respects they are identical. Hence I consider them conspecific, not as two separate species.

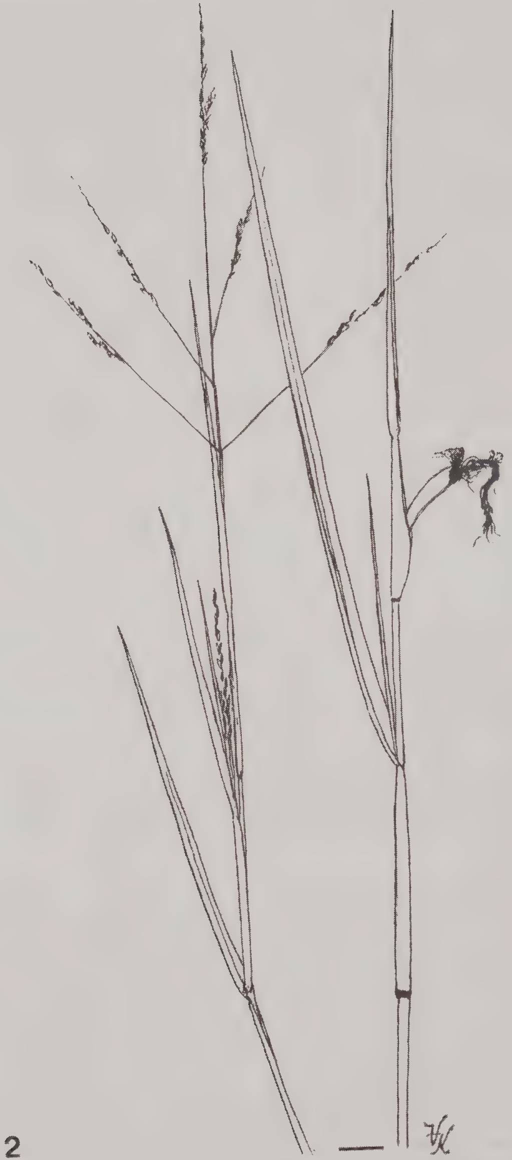

Fig. 2. A sorus of *Sporisorium panicicola* destroying the whole inflorescence of *Panicum coloratum* (type). To the left a healthy inflorescence. Bar = 1 cm.

13. *Sporisorium panicicola* Vánky, **sp. nov.**

Typus in matrice *Panicum coloratum* L. (det. H. Scholz, B), Island of Réunion, 14 km SW oppid. St.-Benoît, Lake Le Grand Etang, 21°05' S, 55°39' E, alt. cca. 500 m.s.m., 2.XII.1994, leg. C. & K. Vánky, HUV 20586; isotypi in Vánky, Ust. exs. no. 1238. Paratypi on *Panicum dichotomiflorum* Michaux, USA, Kansas, Osborne, VII.1894, leg. C.L. Shear, in Ellis & Ev., Fgi. Columbiani no. 748, HUV 16221!; USA, Montana, Stillings, X.1909, leg. E. Bartholomew, in Bartholomew, Fgi. Columbiani no. 3083, HUV 16306!

Sori inflorescentiam totam destruentes, cylindricales vel ovoidales, 2-10 x 10-50 mm, primum peridio crasso, albido vel flavidobrunneo cooperti, quo irregulariter rupto massam atrobrunneam, semiagglutinatam usque pulveream glomerulorum sporarum, sporarum cellularumque sterilium et columellarum plurium ostendentes. *Glomeruli sporarum* subglobosi, ovoidei, ellipsoidales, elongati vel irregulares, 30-100 x 40-150 μm, atrorubrobrunnei usque opaci, e pluries decem sporarum leviter separabilium compositi. *Sporae* globosae, subglobosae, ovoideae, ellipsoidales vel parum irregulares, 8-12 x 9-13(-14,5) μm, flavidobrunneae; pariete parum inaequali, 0,5-1 μm crasso, dense, humiliter echinulato, imago obliqua sporarum leniter serrulata. *Cellulae steriles* paucae, singulae vel in catervis parvis irregularibus, cellulae singulae globosae, subglobosae, ellipsoidales vel irregulares, cum latere uno vel lateribus nonnullis deplanatis, 7-13 x 8-16 μm, hyalinae; pariete 0,5-1 μm crasso, levi.

Sori (Fig. 2) destroying the whole inflorescence, cylindrical or ovoid, 2-10 x 10-50 mm, first covered by a thick, whitish or pale yellowish-brown peridium which ruptures irregularly disclosing the dark brown, semiagglutinated to powdery mass of spore balls, spores and sterile cells and numerous, filiform columellae. *Spore balls* (Figs. 6, 7) subglobose, ovoid, ellipsoidal, elongated or irregular, 30-100 x 40-150 μm, dark reddish-brown to opaque, composed of tens of spores which separate easily. *Spores* (Figs. 6, 7) globose, subglobose, ovoid, ellipsoidal or slightly irregular, 8-12 x 9-13(-14.5) μm, yellowish-brown; wall slightly uneven, 0.5-1 μm thick, densely low echinulate, spore profile finely serrulate. *Sterile cells* few, single or in small, irregular groups, single cells globose, subglobose, ellipsoidal or irregular, with one or several flattened sides, 7-13 x 8-16 μm, hyaline; wall 0.5-1 μm thick, smooth.

On *Panicum coloratum* L., *P. dichotomiflorum* Michaux (*P. proliferum* Lam.); Africa, Mascarene Islands (Island of Réunion), N. America (USA).

Sporisorium panicicola is close to *Ustilago syntherismae* (Schwein.) Peck (on *Digitaria* spp.), in which peridium, spore balls and sterile cells are lacking and the spores are sparsely to moderately densely low echinulate. *S. panicicola* differs from *S. scheffleri* (type on *Panicum coloratum*, Kenya) especially in the morphology of the spores, Those in *S. scheffleri* are 8-12 μm long, the spore wall is even, 0.5-0.8 μm thick, finely, densely punctate-verruculose, the spore profile is smooth to very finely wavy.

14. *Sporisorium panici-fasciculati* Vánky, **sp. nov.**

Typus in matrice *Panicum fasciculatum* Swartz, Ecuador, Manabi Province, 35 km E urbe Portoviejo, 5 km E pag. San Plácido, 1°04' S, 80°12' W, alt. cca. 150 m.s.m., 11.III.1993, leg. C. & K. Vánky, HUV 17439; isotypi in Vánky, Ust. exs. no. 1232.

Sori in omnibus floribus inflorescentiae eiusdem, ovoidei usque ellipsoidales, 1-1,5 x 3-4(-5) mm, aliquando cum residuis involucrorum floralium internorum, primo peridio satis crasso, flavidobrunneo cooperti, quo irregulariter rupto massam nigrobrunneam, pulveream glomerulorum sporarum et sporarum columellam brevem, simplicem, parum arcuatum, centralem, cum ramulis eius in parte distali brevibus, spiniformibus

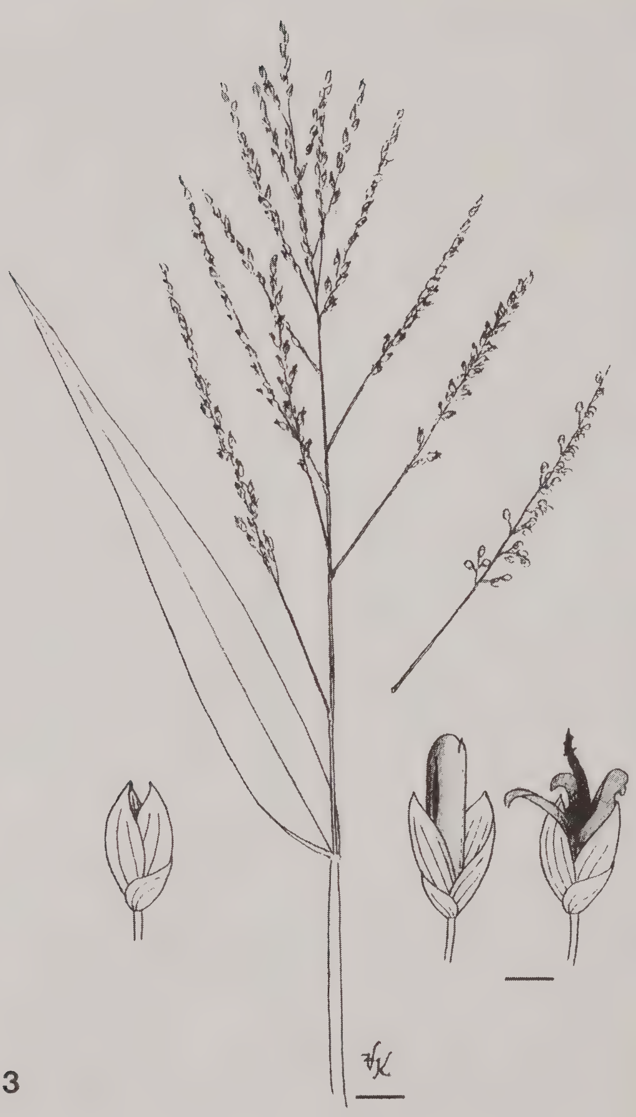

Fig. 3. Sori of *Sporisorium panici-fasciculati* in all flowers of *Panicum fasciculatum* (type). Habit of an infected inflorescence and, separate, a branch of a healthy inflorescence. Enlarged two spikelets with sori and a healthy spikelet.
Bars = 1 cm for habit, and 1 mm for the detail drawings.

circumdantium ostendentes. *Glomeruli sporarum* globosi, subglobosi, ellipsoidales, elongati vel parum irregulares, 30-60 x 40-90 μm, atro-rubrobrunnei usque opaci, e sporis 15 usque 100(?) valde leviter separabilibus compositi. *Sporae* subglobosae, ovoideae vel parum irregulares, 9-12,5 x 11-14 μm, mediocriter atro-rubrobrunneae; pariete aequali, cca. 1 μm crasso, dense, prominenter, humiliter echinulato; imago obliqua sporarum leniter serrulata. *Cellulae steriles* absentes.

Sori (Fig. 3) in all flowers of an inflorescence, ovoid to ellipsoidal, 1-1.5 x 3-4(-5) mm, sometimes with remnants of inner floral envelopes, first covered by a rather thick, yellowish-brown peridium which ruptures irregularly exposing the blackish-brown, powdery mass of spore balls and spores surrounding a short, simple, slightly bent, central columella with short,

spike-like branches on its distal part. *Spore balls* (Figs. 8, 9) globose, subglobose, ellipsoidal, elongated or slightly irregular, 30-60 x 40-90 μm, dark reddish-brown to opaque, composed of 15 to a hundred(?) spores which separate very easily. *Spores* (Figs. 8, 9) subglobose, ovoid or slightly irregular, 9-12.5 x 11-14 μm, medium dark reddish-brown; wall even, c. 1 μm thick, densely, prominently, low echinulate, spore profile finely serrulate. *Sterile cells* absent. *Spore germination* (Fig. 28; on water-agar, in 5 days, at room temp.) results in 4-8-celled phragmobasidia on which septate hyphae and elongated basidiospores are produced.

On *Panicum fasciculatum* Swartz. Know only from the type collection.

15. *Sporisorium panici-hirticaulis* Vánky, **sp. nov.**

Typus in matrice *Panicum hirticaule* J. Presl (det. C.E. Benitez, MY), Venezuela, Estado Guárico, cca. 80 km E oppid. Altagracia de Orituco, 9°53' N, 65°46' W, alt. cca. 400 m.s.m., 9.XII.1993, leg. R. Berndt, C. & K. Vánky, HUV 20044; isotypi in VIA 6992 et in Vánky, Ust. exs. no. 1233.

Sori in floribus nonnullis inflorescentiae eiusdem, in eodem spiculo 1 vel 2, globoidei, ovoidei vel ellipsoidales, 1-1,5 x 1-2 mm, aliquando apice acuto ex residuis involucrorum floralium internorum formato, primo peridio cinereo vel flavidobrunneo cooperti, quo irregulariter rupto massam atrobrunneam, semiagglutinatam usque pulveream sporarum et cellularum sterilium columellam brevem, simplicem circumdantium ostendentes. *Sporae* in maturitate singulae, forma et magnitudine variae, globosae, subglobosae, ovoideae vel ellipsoidales, raro valde elongatae, 5-7 x 5,5-9,5(-12) μm, pallide flavidobrunneae; pariete aequali, cca. 0,5 μm crasso, leniter, mediocriter dense echinulato, imago obliqua sporarum levis, leniter undulata vel leniter serrulata. *Cellulae steriles* in catervis irregularibus, cellulae singulae globosae, ellipsoidales vel irregulares, 4-7 μm longae, hyalinae; pariete tenui (cca. 0,4 μm), levi.

Sori (Fig. 10) in some flowers of an inflorescence, one or two in a spikelet, globoid, ovoid or ellipsoidal, 1-1.5 x 1-2 mm, sometimes with an acute tip of remnants of inner floral envelopes, first covered by a grey or yellowish-brown peridium which ruptures irregularly disclosing the dark brown, semiagglutinated to powdery mass of spores and sterile cells surrounding a short, simple columella. *Spores* (Figs. 14, 15) when mature single, variable in shape and size, globose, subglobose, ovoid or ellipsoidal, rarely very elongated, 5-7 x 5.5-9.5(-12) μm, pale yellowish-brown; wall even, c. 0.5 μm thick, finely, moderately densely echinulate, spore profile smooth, finely wavy or finely serrulate. *Sterile cells* in irregular groups, single cells globose, ellipsoidal or irregular, 4-7 μm long, hyaline; wall thin (c. 0.4 μm), smooth.

On *Panicum hirticaule* J. Presl. Know only from the type locality.

16. *Sporisorium panici-leucophaei* (Bref.) M. Piepenbring, 1999:465.

Ustilago panici-leucophaei Brefeld, 1895:114. — *Sphacelotheca panici-leucophaei* (Bref.) G.P. Clinton, 1906:28. — *Lundquistia panici-leucophaei* (Bref.) Vánky, 2004c:167.— Type on *Panicum leucophaeum* (= *Trichachne insularis*), Brazil, Rio de Janeiro, coll. E. Ule, HBG.

For taxonomic synonyms as *Lundquistia fascicularis* Vánky, *Sorosporium lindmanii* Zundel, *Sphacelotheca viegasiana* Zundel, *Ustilago bonariensis* Speg., *U. garcesii* Zundel, *U. insularis* Henn., their synonyms, literature and host plants, see Vánky, 2004c:167.

Sori comprise the uppermost leaves of sterile shoots, the floral stem and often also a more or less developed inflorescence or only part of it. They are long cylindrical, often twisted and tapering towards the apex, 0.2-0.8 x 4-15 cm, usually partly enclosed by healthy leaf sheaths. In the sori, the parenchymatous tissues between the veins are replaced by the dark brown, semiagglutinated or granular-powdery mass of spore balls and spores disclosed by the rupturing of the covering epidermis, leaving behind the typical fascicles of vascular bundles. *Spore balls* globose, subglobose, ellipsoidal, oblong to slightly irregular, 20-70 x 25-90 μm, yellowish- brown to dark brown, composed of many spores, rather permanent when young, later separating. *Spores* globose, subglobose, broadly ellipsoidal to slightly, subpolyhedrally irregular, 5.5-8 x 6-9.5 μm, yellowish-brown; wall evenly thick (c. 0.5 μm), finely, moderately densely punctate-verruculose, spore profile smooth to just finely wavy; in SEM finely verrucose-echinulate. *Sterile cells* absent.

On *Digitaria brownii* (Roem. & Schult.) Hughes, *D. horizontalis* Willd., ?*Echinochloa polystachya* (H. B. K.) Hitchc. (*Panicum spectabile* Nees), *Oplismenopsis najada* (Hack. & Arechav.) Parodi (*Panicum najadum* Hack. & Arechav.), *Panicum elephantipes* Nees, *Trichachne californica* (Benth.) Chase (*Panicum californicum* Benth.; *Digitaria californica* (Benth.) Henr.; *T. saccharata* (Buckl.) Nash), *T. insularis* (L.) Nees (*Digitaria insularis* (L.) Fedde; *Panicum lanatum* Rottb.; *P. leucophaeum* H. B. K.), *T. sacchariflora* (Raddi) Nees; Australia, N., C. & S. America, including the West Indian Antilles.

17. *Sporisorium scheffleri* (Syd. & P. Syd.) Vánky, **comb. nov.**

Basionym: *Ustilago scheffleri* H. & P. Sydow, Bot. Jahrb. Syst. 45:262, 1911. — Type on "*Pennisetum inclusum* Pilger" (= misnamed *Panicum coloratum*, teste H. Scholz, sec. Vánky, 2003a:19), „Massaihochland, Lamuru" (=? Kenya, Kiambu Distr., Limuru), alt. 3000 m, 30.VI.1909, G. Scheffler 293; isotypes in BPI 166232, 194468, K, M, HUV 12741!

Sori destroying the whole inflorescence, 1-2 mm wide, up to 3 cm long, first covered by a thin, greyish peridium which ruptures irregularly disclosing the dark brown,

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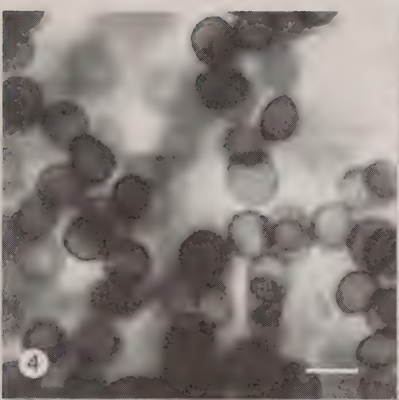
Figs. 4, 5. Spores and sterile cells of *Macalpinomyces panici* on *Panicum aequinerve*, in LM and in SEM (type).

Figs. 6, 7. Spore balls, spores and sterile cells of *Sporisorium panicicola* on *Panicum coloratum*, in LM and in SEM (type).

Figs. 8, 9. Spore balls and spores of *Sporisorium panici-fasciculati* on *Panicum fasciculatum*, in LM and in SEM (type). In the LM picture, a young spore ball can be seen with a few, nearly colourless, immature spores surrounded by a hyaline fungal matrix. Bars = 10 μm.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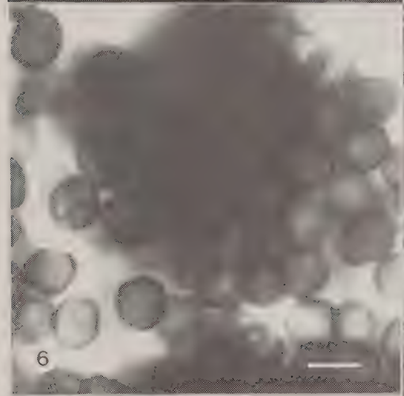
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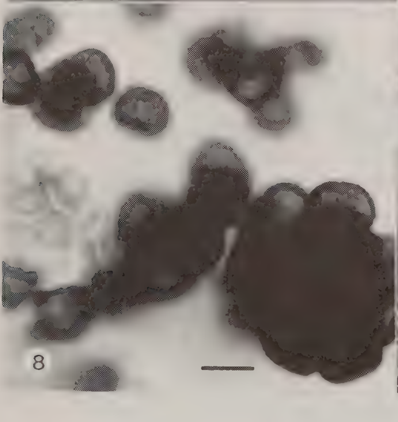
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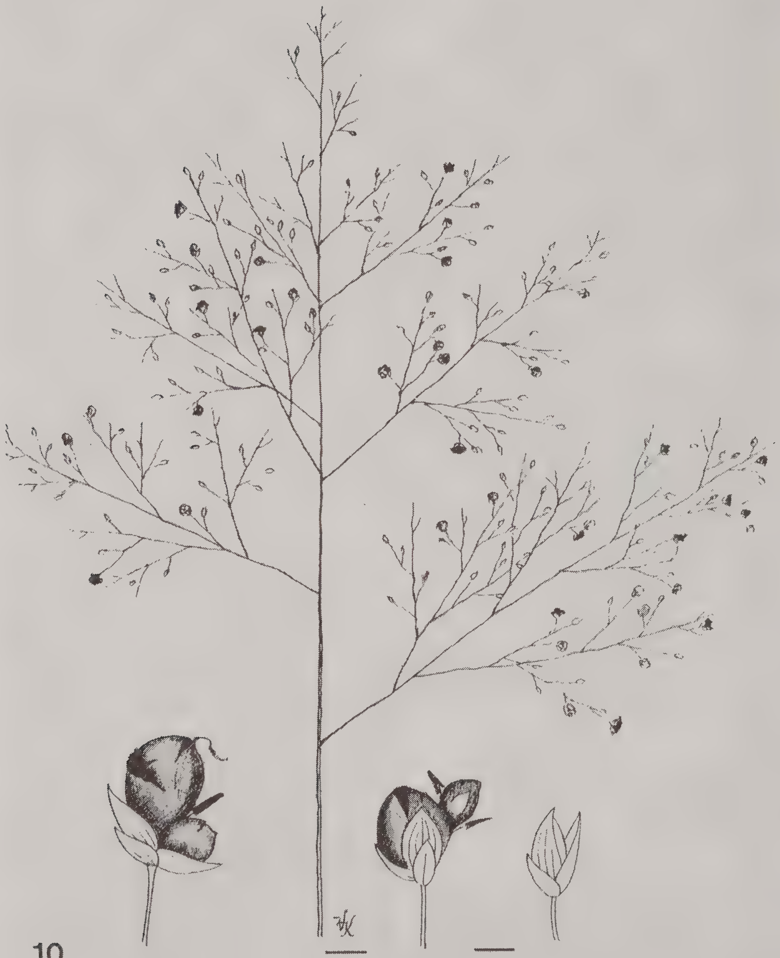

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Fig. 10. Sori of *Sporisorium panici-hirticaulis* in some flowers of *Panicum hirticaule* (type). Habit, and enlarged two spikelets with sori and a healthy spikelet.
Bars = 1 cm for habit, and 1 mm for the detail drawings.

powdery mass of spores surrounding several, long, filiform columellae. *Spores* when mature single, ellipsoidal, ovoid, more rarely globose or slightly irregular, (6.5-)7-9.5 x 8-12 μm, yellowish-brown; wall even, 0.5-0.8 μm thick, finely, densely punctate-verruculose, spore profile smooth to very finely wavy, in SEM finely, densely verrucose, between the warts minutely verruculose. *Sterile cells* not seen.

On *Panicum coloratum* L.; E. Africa (Kenya).

Because of presence of a thin peridium and several columellae it is better to place this fungus into the genus *Sporisorium*. In the original description, the spores are given as reticulate. This was corrected by Zundel (1953:197).

18. ***Sporisorium spegazzinii*** Vánky, 2003a:33.

Nom. nov. pro *Sorosporium argentinum* Speg., not *Sporisorium argentinum* (Hirschh.) Vánky, 2003a:58. — *Ustilago argentina* (Speg.) Spegazzini, 1925:151. — Type on „*Tricholaena insularis*“ (= misnamed *Panicum urvilleanum*; Spegazzini, 1925:151), Argentina, Prov. Rioja, near Vinchina, leg. G. Hieronymus, LPS ?

Ustilago negeriana Dietel, 1898:(147). — Type on *Panicum urvilleanum*, Chile, Prov. Concepción, near Yumbel, coll. F. Neger, BPI 179441. (syn. by Spegazzini, 1925:151).

Sori in the flowers, infecting all in a panicle, inconspicuous, destroying the inner floral organs, protected by the outermost floral envelopes, 1.5-2 x 2-2.5 mm, first covered by a yellowish-brown peridium which ruptures at maturity from its distal part disclosing the semiagglutinated to powdery, dark brown mass of spore balls and spores surrounding three, short, simple or distally bifurcate columellae. *Spore balls* subglobose, ellipsoidal to slightly irregular, 35-90 x 45-130 μm, dark reddish-brown, composed of tens to hundreds of easily separating spores. *Spores* subpolyhedrally irregular, more rarely subglobose or ellipsoidal, yellowish-brown, 8-10.5 x 9-12(-13) μm; wall in LM c. 0.5 μm thick, in some places thinner (which is difficult to see), surface smooth to very finely and inconspicuously punctate; in SEM the spores have several (6-8?), often mamillate depressions, surface very finely, densely verruculose. *Sterile cells* not seen.

On *Panicum urvilleanum* Kunth; S. America (Argentina, Chile).

19. ***Sporisorium tanganyikeanum*** (Zundel) Vánky, **comb. nov.**

Basionym: *Sorosporium tanganyikeanum* Zundel, Mycologia 36:408, 1944. — Type on *Panicum repens*, Tanganyika Territory [Tanzania], Kigoma, 24.I.1927, D.H. Linder, BPI 195129 (Flora of Tropical Africa no. 1955); isotype BPI 180801!

Sori destroying the whole inflorescence, cylindrical, 1.5-3 mm x 4-4.5 cm, partially concealed by leaf sheaths, first covered by a yellowish-brown peridium which flakes away disclosing the dark brown, powdery mass of spores balls and spores surrounding several (5-8), filiform columellae. *Spore balls* globose, ovoid, ellipsoidal, elongated or irregular, 30-80 x 40-100 μm, dark brown, composed of tens of spores which separate easily. *Spores* globose, subglobose, ovoid, broadly ellipsoidal to subpolyhedrally slightly irregular, 5.5-8 x 6.5-9.5 μm, yellowish-brown; wall even, c. 0.5 μm thick, finely, densely punctate-verruculose, spore profile smooth.

On *Panicum repens* L.; C. Africa. Known only from the type collection.

20. *Sporisorium vesiculosum* (Henn.) M. Piepenbring, 2003:135.

Ustilago vesiculosa Hennings, in Pazschke, 1896:51. — Lectotype on *Panicum* sp. (= *Panicum demissum*, = *P. sabulosum*), Brazil, Estado de Rio de Janeiro, (design. here) Campo Bello, II.1894, E. Ule 2080, HBG; isolectotype BPI 194483! Syntype: Estado de Rio de Janeiro, Serra do Itatiaia, II.1894, E. Ule 2083, HBG; isosyntype BPI 169400!

Ustilago panici-carthagenensis Spegazzini, 1899:207. — *Sorosporium panici-carthagenensis* (Speg.) Zundel, 1951:268. — *Sporisorium panici-carthagenensis* (Speg.) Vánky, 2003a:59. — Type on *Panicum carthagenense* (= *P. fultum*), Uruguay, Dept. Montevideo, Cerro de Montevideo, summer 1882, J. Arechavaleta & C. Spegazzini, LPS 3029. Topotype on *P. fultum*, VI.1927, G. Herter, HUV 5216! (syn. by Piepenbring, 2003:135, confirmed)

Sphacelotheca echinata Zundel, 1931:298. — Lectotype (designated here) on *Panicum demissum* (= *Panicum sabulosum*), Brazil, State Minas Gerais, Serra do Caparaó, 30.IV.-4.V.1925 (as „20".IV.), A. Chase 9731, BPI 60371 (= BPI 177488!); isotype BPI 177490! Syntypes on *Panicum missionum*, Brazil, São Paulo, Serra Mantiquiera, Campos do Jordão, 20-22.V.1925, A. Chase 9815, BPI 60358 (= BPI 177494!), BPI 177489! (syn. by Ling, 1951b:102, confirmed).

Crozalsiella argentina Hirschhorn, 1940:236. — *Sphacelotheca argentina* (Hirschh.) Zundel, 1953:81. — *Sporisorium argentinum* (Hirschh.) Vánky, 2003a:58. — Type on *Panicum demissum* (= *P. sabulosum*), Argentina, Buenos Aires, Hudson, Villa Elisa, X.1924, J.B. Marchionatto, LPS 3649! (syn. nov.).

Sori destroying the whole inflorescence and also the basal part of the terminal leaf sheaths, swollen, globoid, 3-5 x 3-5 mm, with an acute tip bearing a more or less well-developed leaf blade, covered by a brown peridium of fungal and host origin which ruptures irregularly disclosing the dark brown, semiagglutinated to powdery mass of spore balls, spores and sterile cells surrounding several short, stout, bent columellae. *Spore balls* composed of many, easily separating spores. *Spores* when mature single, variable in shape and size, subglobose, ovoid, broadly ellipsoidal, irregular, often with a flattened side or even kidney-shaped, sometimes elongated into a subacute tip, (6-)7-9.5(-11) x 8.5-13 μm, yellowish-brown; wall 0.5-1 μm thick, thinner at the flattened sides, finely, densely, uniformly verrucose-echinulate, spore profile smooth to finely wavy. *Sterile cells* in irregular, small groups, single cells subglobose, ellipsoidal to irregular, 8-15 μm long, hyaline, collapsed in old specimens; wall c. 0.5 μm thick, smooth.

On *Panicum fultum* Hack. (*P. carthagenense* Arechav., not Sw.; *P. fasciculatum* Sw. var. *carthagenense* Arechav.), *P. missionum* Mez, *P. sabulosum* Lam. (*P. demissum* Trin.), *Panicum* sp.; S. America (Argentina, Brazil, Uruguay).

The specimens distributed in Rbh., Fgi. eur. no. 4008 as *Ustilago panici-miliacei* (Pers.) Winter on *Panicum* sp., Brazil, represent *S. vesiculosum*.

21. *Tilletia banarasae* Pavgi & Thirum., in Thirum. & Pavgi, 1956:285.

Type on *Panicum trypheron*, India, Uttar Pradesh, Banaras (Varanasi), 14.IX.1952, M.S. Pavgi, HCIO 20986; isotypes IMI, HUV 17318! (The correct ending would be *T. banaras-ensis*, *-ica*, or *-ina*; ICBN Rec. 60 D).

Sori in some ovaries of an inflorescence, globoid to ovoid, 1.5-3 mm long, showing between the spreading glumes, first covered by the dark brown pericarp which ruptures irregularly disclosing the black, semiagglutinated to powdery mass of spores intermixed with sterile cells. *Spores* globose, subglobose, ellipsoidal, 16-21.5 x 17-23 μm, yellowish- to reddish-brown; provided with coarse, 1.5-3 μm high, blunt warts; in surface view appearing as dark, polyangular spots, 5-10 per spore diameter, in optical median view 21-30 on the equatorial circumference. *Sterile cells* globose, ellipsoidal or irregular, 10-20 x 12-20 μm, pale yellowish-brown, collapsed in old specimens; wall 1-1.5 μm thick, smooth or with a trace of ornamentation.

On *Panicum trypheron* Schult.; S. Asia (India). Known only from the type collection.

22. *Tilletia biharica* Thirumalachar & Pavgi, 1953:101.

Type on *Panicum* sp., India, Bihar, Parasnath, 14.XII.1952, H.C. Govindu, HCIO; isotype HUV 17319!

Sori in some ovaries of an inflorescence, ovoid or ellipsoidal, 2-2.5 x 3-5 mm, covered by the brownish pericarp which opens apically disclosing the dark brown, powdery mass of spores intermixed with numerous sterile cells and intermediate forms. *Spores* globose, subglobose, rarely ellipsoidal, variable in size, 16-24(-26) x 16-24(-26) μm, pale to dark yellowish brown to nearly subopaque; wall 3-4.5 μm thick, including the densely situated, 1-1.5 μm high warts with flattened top; in surface view warts polyangular, 9-13 per spore diameter, in optical median view 33-43 warts on the equatorial circumference. *Sterile cells* globose, subglobose, ellipsoidal, irregular, variable in size, 11-44 x 12-44 μm, subhyaline or with yellowish-brown tint; wall 1.5-7 μm thick, smooth. The intermediate forms („immature spores“) are of various size and colour having abnormal ornamentation from nearly smooth, punctate-verruculose to nearly typical warts.

On *Panicum* sp.; S. Asia (India).

23. *Tilletia courtetiana* Hariot & Patouillard, 1909:197.

Type on *Panicum proliferum* var. *longijubatum* (= *P. subalbidum*), Congo, Banguirmi, Abougher, 25.-31.VIII.1903, Hariot & Patouillard 9636, PC; isotype HUV 12057!

Sori in some ovaries of an inflorescence, hypertrophied, ovoid, ellipsoidal or subcylindrical, 1.5-3 x 2-4 mm, protruding between the spreading floral envelopes, first covered by the greyish-brown pericarp which ruptures irregularly disclosing the reddish-brown, powdery mass of spores intermixed with sterile cells. *Spores* globose or subglobose, 16-24 x 17-26 μm, pale yellowish-brown; wall reticulate, 3-5 meshes per spore diameter, muri 1.5-2.5 μm high, blunt. *Sterile cells* globose, subglobose to ellipsoidal, 13-23 x 15-23 μm, subhyaline; wall 1-1.5 μm thick, smooth.

On *Panicum dichotomiflorum* Michaux (*P. proliferum* Lam.), *P. subalbidum* Kunth (*P. longijubatum* (Stapf) Stapf; *P. proliferum* Lam. var. *longijubatum* Stapf); C. Africa (Congo).

24. *Tilletia maclaganii* (Berk.) G.P. Clinton, 1902:148.

Ustilago maclaganii Berkeley, 1874:58 (as „*maclagani*“). — Type on *Panicum virgatum*, Canada, Montreal, leg. Maclagan 515.

Ustilago rotundata Arthur, 1884:173. — *Tilletia rotundata* (Arthur) Massee, 1899:145.

(Ellis & Everhart, in N. Amer. fgi. no. 1894, 1887, called the fungus *Ustilago rotundata* Arthur, but said that it is a *Tilletia*, which does not constitute a new combination). — Type on *Panicum virgatum*, USA, Iowa, Harrison Co., BPI 173598! (syn. by Clinton, 1902:129, confirmed).

Sori in all ovaries of a normal or somewhat stunted inflorescence, ovoid, 0.5-1 x 1-1.5 mm, hidden by the floral envelopes and enclosed by the thin pericarp which ruptures irregularly disclosing the rusty-brown, agglutinated to powdery mass of spores and sterile cells. *Spores* globose, subglobose, ovoid, ellipsoidal or slightly irregular, 16-22 x 17-25 μm, pale yellowish-brown to orange-yellow; wall 2.5-4 μm thick, provided with densely situated, 2-3.5 μm long, filiform warts, spore profile wavy to finely serrulate. *Sterile cells* globose, ovoid to slightly irregular, 10-22 x 12-24 μm, subhyaline to pale yellow; wall 1.5-3 μm thick, smooth to finely punctate.

On *Panicum glabripes* Doell. (*P. subjunceum* Ekm.), *P. virgatum* L., *P. virgatum* var. *spissum* Linder, according to Hirschhorn (1986:183) also on *Panicum racemosum* (P. Beauv.) Sprengel, and *P. urwilleanum* Kunth; N. America (Canada, USA), S. America (Argentina, Uruguay).

25. *Tilletia mexicana* Vánky, **sp. nov.**

Typus in matrice *Panicum hallii* Vasey, Mexico, Nuevo León State, 18.5 km N oppid. Vallecillo, 1.8 km N pag. San Marcos, alt. cca. 242 m.s.m., 24.XI.1978, leg. R. Durán et P.M. Gray (ut *T. narasimhanii*). Holotypus in HUV 14472!, isotypus WSP 68801.

Sori in ovariis nonnullis eiusdem inflorescentiae, tumefacti, ovoidei, 1,5-2 x 2-3 mm, inter involucris floralibus conspicui, pericarpio crasso, primum viridi, deinde brunneo cooperti, quo irregulariter rupto massam atrobrunneam, pulveream sporarum cellularumque sterilium ostendentes. *Sporae* globosae vel subglobosae, 24-28 x 25-29 μm, flavidobrunneae, reticulatae, maculis polyangularibus, 4-6 in diametro sporae, muris 2-2,5 μm altis, obtusis, interspatiis verruculosis. *Cellulae steriles* globosae, subglobosae usque parum irregulares, 12-25 x 13-28 μm, hyalinae; pariete 1,5-3,5 μm crasso, levi, raro appendice hyalina instructo. Formae intermediatae paucae, subhyalinae, cum vestigio reticuli.

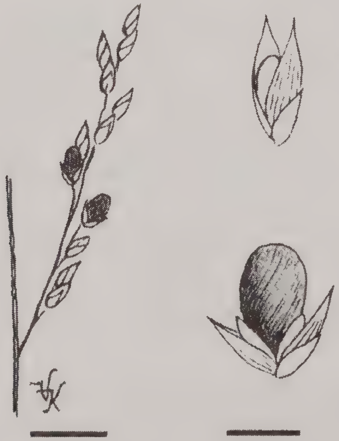

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Fig. 11. Sori of *Tilletia mexicana* in the ovaries of Panicum hallii (type). Enlarged a sorus and a healthy spikelet. Bars = 1 cm for habit, and 2 mm for the detail drawings.

Sori (Fig. 11) in some ovaries of an inflorescence, swollen, ovoid, 1.5-2 x 2-3 mm, showing between the spreading floral envelopes, covered by the thick, first green later brown pericarp which ruptures irregularly disclosing the dark brown, powdery mass of spores and sterile cells. *Spores* (Figs. 16, 17) globose or subglobose, 24-28 x 25-29 μm, yellowish-brown, reticulate, meshes polyangular, 4-6 per spore diameter, muri 2-2.5 μm high, blunt, interspaces verruculose. *Sterile cells* (Figs. 16, 17) globose, subglobose to slightly irregular, 12-25 x 13-28 μm, hyaline; wall 1.5-3.5 μm thick, smooth, rarely with a hyaline appendage. Intermediate forms few, subhyaline, with traces of a reticulum. *Spore germination* (Durán, 1987:159) results in simple, sometimes branched holobasidia, bearing an apical whorl of numerous, acicular, 1-3-septate basidiospores, with mononucleate cells.

On *Panicum hallii* Vasey; N. America (Mexico).

Tilletia mexicana differs from *T. narasimhanii* (type on *Panicum trypheron*, India), especially in having larger spores, higher muri, verrucose interspaces and larger sterile cells with thicker wall.

26. *Tilletia narasimhanii* Thirumalachar & Safeeulla, 1951:442.

Type on *Panicum trypheron*, India, Bihar, Patna, 2.VIII.1950, M.J. Narasimhan; isotype WSP 64524! (poor material).

Sori in some ovaries of an inflorescence, swollen, ovoid, 2-3 x 3-4 mm, showing between the spreading floral envelopes, first covered by the thick, brown pericarp which ruptures irregularly disclosing the dark brown, powdery mass of spores and sterile cells. *Spores* globose, subglobose, ovoid to broadly ellipsoidal, 20-24 x 21.5-26 μm, yellowish-brown; spore wall reticulate, meshes polyangular, 4-6 per spore diameter, muri 1-1.5 μm high, blunt, encased in a thin, hyaline sheath. *Sterile cells* numerous, globose, ellipsoidal to slightly irregular, 10.5-19 x 12-20 μm, hyaline; wall 1-2 μm thick, smooth. Intermediate forms yellow-tinted, with a trace of reticulum.

On *Panicum sumatrense* Roth ex Roem. & Schult. (*P. miliare* Lam.), *P. trypheron* Schult.; S. Asia (India).

Description based on a collection on *Panicum sumatrense*, India, Jabalpur, 11.X.1992, N.D. Sharma *et al.*, HUV 16012.

27. *Tilletia narayanaraoana* Mundkur & Thirum., in Thirumalachar & Mundkur, 1951:6.

Type on *Panicum trypheron*, India, Mysore, Yashavantapur, 15.XII.1944, M.J. Thirumalachar, HCIO; isotype HUV 15604!

Sori in some ovaries of a panicle, ovoid or subcylindrical, 1-2 x 1.5-5 mm, protruding between the floral envelopes, first covered by the brown pericarp which opens at its paler coloured apex, disclosing the dark brown, semiagglutinated to powdery mass of spores intermixed with sterile cells. *Spores* globose, subglobose, ellipsoidal, (15-)16-23 x (16-)20-28 μm, dark yellowish-brown; provided with 1.5-3 μm long, densely situated, filiform warts, usually agglutinated into small, irregular groups. *Sterile cells* subglobose, ellipsoidal, usually slightly irregular, 8-16 x 13-21 μm, pale yellowish-brown; wall 2-2.5 μm thick, smooth to finely punctate. *Spore germination* (Thirumalachar & Mundkur, 1951:6) results in a holobasidium bearing a terminal whorl of 12-16 basidiospores which conjugate.

On *Panicum hallii* Vasey, *P. hirticaule* J. Presl, *P. trypheron* Schult.; S. Asia (India), N. America (Mexico).

28. *Tilletia panici-humilis* Pavgi & Thirumalachar, 1955:89.

Type on *Panicum humile*, India, Uttar Pradesh, Banaras, 24.IX.1953, M.S. Pavgi; isotypes WSP 64578, 64579, 64580! (scanty material).

Sori in some ovaries of an inflorescence, inconspicuous, globoid, 1.5-2 mm in diameter, dark brown, showing between the spreading glumes, first covered by the pericarp which ruptures irregularly disclosing the blackish-brown, powdery mass of spores intermixed with sterile cells. Sometimes only parts of the seeds are destroyed. *Spores* globose, subglobose, ovoid or ellipsoidal to rarely elongated, 17-23 x 18-25(-27) μm, pale to dark yellowish- to reddish-brown, provided with narrow, 1.5-2.5 μm high warts with acute, subacute or flattened tip encased in a thin, hyaline sheath; warts in surface view appear as slightly darker, polyangular spots, 7-12 per spore diameter, rarely 2-3 warts may fuse, in optical median view 26-37 on the equatorial circumference. *Sterile cells* subglobose, ovoid or irregular, 12-20(-28) x 13-25(-32) μm, subhyaline; wall 1.5-2(-3) μm thick, smooth. Intermediate forms are subhyaline to pale yellow, thick-walled, from punctate to verruculose-echinulate, up to 15 warts per spore diameter.

On *Panicum humile* Nees, *P. obtusum* H.B.K., *P. sumatrense* Roth ex Roem. & Schult.; S. Asia (India), N. America (Mexico).

In the original description the spores are reticulate. Durán & Fischer (1961:125) showed that the spores are not reticulate but „scaly".

Durán & Fischer (1961:35) and Durán (1987:148) considered the *Tilletia* on *Panicum obtusum* to be *T. barclayana* (Bref.) Sacc. & P. Syd. (type on *Pennisetum triflorum* Nees, = *P. orientale* Rich, India). However, this bunt fits better with *T. panici-humilis*, which differs from *T. barclayana* in the morphology of the sori and that of the spores and sterile cells. In *T. barclayana* the sori are obovoid, 3-6 mm long, with an apical opening. The spore mass is black. The spores are mostly globose or subglobose, 20-24 x 20-24 μm, chocolate-brown to subopaque, provided with 1-2 μm high, polyangular warts with flattened top, 8-13 per spore diameter, not confluent. The sterile cells (15-32 μm long) are pale yellowish-brown tinted with a 2.5-8 μm thick wall (description of *T. barclayana* is based on *P. orientale* from India, in Vánky, Ust. exs. no. 836).

29. *Tilletia pulcherrima* Ellis & Galloway ex G.P. Clinton, 1904:441.

Neovossia pulcherrima (Ellis & Galloway ex G.P. Clinton) Vánky, 1990:272. — Lectotype on *Panicum virgatum*, USA, Illinois, (design. by Vánky, 1990:272) Champaign, 8.IX.1897, G.P. Clinton, HUV 9647!; isolectotype in Seymour & Earle, Econ. fgi., Suppl. C, no. 52. Syntype: USA, Mississippi, Starkville, 7.X.1895, S.M. Tracy, HUV 9811; isosyntypes in Seymour & Earle, Econ. fgi. no. 543 (as *T. rotundata*).

Sori in some ovaries of an inflorescence. *Spores* globose, subglobose, rarely broadly ellipsoidal, 20-28 x 20-29.5 μm, dark reddish-brown, provided with 1-1.5 μm high, blunt warts encased in a hyaline sheath, occasionally with a short, hyaline appendage, the remnant of the sporogenous hypha; warts in surface view appear as dark, polyangular spots, 9-15 per spore diameter, often two or several fusing into irregular spots, in optical median view 27-47 warts on the equatorial circumference. *Sterile cells* globose, ellipsoidal, slightly irregular or lacrymiform, 11-22 x 12-25 μm, subhyaline; wall 1.5-3 μm thick, smooth, often with a short appendage.

On *Echinochloa crus-galli* (L.) P. Beauv. (*Panicum crus-galli* L.), *Panicum sanguinale* L. (*Digitaria sanguinalis* (L.) Scop.), *P. virgatum* L.; Asia, N. America (USA).

Durán & Fischer (1961:35) considered *T. pulcherrima* a synonym of *T. barclayana.*

30. *Tilletia tumefaciens* Syd. & P. Syd., in Sydow, H. &. P. & Butler, 1912:255.

Type on *Panicum antidotale*, India, Punjab, Lyallpur Farm, 30.IX.1908, D. Milne, HCIO 1446; isotypes HUV 17325, S.

Sori in the axillary buds, usually at the base of the plant, producing hypertrophy, deformation and proliferation of the leaves and bud scales, resulting in globoid, elongated or finger-like witches‘ brooms, 2-3 x 9-10 cm, with dark brown, powdery mass of spores and sterile cells with the smell of trimethylamine. The sori are produced usually on the adaxial surface of the leaves whereas the abaxial surface becomes pilose. *Spores* globose, subglobose to ellipsoidal, 16-22 x 17-24 μm, medium dark yellowish-brown; spore wall reticulate, 3-5 meshes per spore diameter, meshes polyangular, sometimes incomplete, muri 1-1.5 μm high, blunt, encased in a thin, hyaline sheath. *Sterile cells* globose, ellipsoidal to irregular, variable in size, 12-28 x 15-32 μm, subhyaline to pale yellowish-brown tinted; wall 1.5-5 μm thick, smooth. Intermediate forms („immature spores“) may occur, are pale yellowish-brown with a trace of reticulum.

On *Panicum antidotale* Retz.; S. Asia (India, Pakistan).

31. *Tilletia verrucosa* Cooke & Massee, in Cooke, 1888:16.

Type on *Panicum coloratum*, Mozambique, between Lupata and Tette, II.1889, coll. Dr. Kirk, K; isotypes BPI 195172!, WSP 34697!

Sori in few or almost all ovaries of an inflorescence, ovoid, 3.5-5 mm long, covered by the rather hard pericarp. Spore mass brown, powdery. *Spores* globose, subglobose to broadly ellipsoidal, 17.5-24 x 19-26.5 μm, very pale yellow to pale yellowish-brown, provided with pyramidal spines, 1.5-2 μm high, 5-8 per spore diameter, 19-25 on the equatorial circumference, sheath apparently lacking. *Sterile cells* globose to ovoid or slightly irregular, 13.5-20 x 16-22 μm, subhyaline; wall 2.5-4 μm thick, smooth to sparsely, minutely verrucose-echinulate.

On *Panicum coloratum* L., *P. miliaceum* L., ?*P. sumatrense* Roth ex Roem. & Schult. (*P. miliare* Lam.), *P. virgatum* L.; S. Africa (Mozambique, S. Africa, Zimbabwe).

The original description of *T. verrucosa* is very short and inexact: „Ovariis inflatis, pallido-fuscis. Sporis globosis, solitariis, fuscis (15-16 μ diam.), episporio verrucose, verrucis obtusis. In the ovariis of *Panicum miliare* (Kirk). Between Lupata and Tette, Tropical Africa“. Durán & Fischer (1961:116) examined the type specimen and wrote that „the spores are considerably larger than 15-16 μm“.

32. *Tilletia vittata* (Berk.) Mundkur, 1940:312.

Ustilago vittata Berkeley, 1853:148. — *Neovossia vittata* (Berk.) Shetty & Safeeulla, 1980(1981):399. — Type on „Oplismenoid grass“ (= *Oplismenus compositus* (L.) P. Beauv., det. C.E. Hubbard), India, Bihar, Parasnath, alt. 4000 ft, before 1854, coll. Hooker.

Tilletia panici Mundkur, 1940:317. — Type on *Panicum* sp., India, Calcutta, I.1928,

K. Bagchee, HCIO 7807; isotypes IMI, HUV 16375. (syn. by Ling, 1949a:123, confirmed).

For description, further synonyms and host plant range of *T. vittata* see Vánky, 2004a:63.

The host plants of *T. vittata* are different *Oplismenus* species in Africa, Asia and N. America. The poor type collection of *T. panici* (= *T. vittata*) on *Panicum*, a closely related genus to *Oplismenus*, represents either an „accidental infection", or the host plant was wrongly identified. *T. vittata* is common in India on both *O. burmanii* (Retz.) P. Beauv. and *O. compositus*.

33. *Tranzscheliella hypodytes* (Schltdl.) Vánky & McKenzie, 2002:156.

Lectotype (= neotype) on *Elymus arenarius* L. (= *Leymus arenarius* (L.) Hochst.), Germany, near Berlin, (design. by Hirschhorn, 1947:74) X.1884, P. Sydow; isoneotypes in Rbh., Fgi. eur. no. 3201, HUV 3784!

For synonyms, detailed description and host plant range see Vánky & McKenzie (2002:156-158).

Sori surrounding distal internodes, naked. *Spores* 3.5-5.5 x 4-6(-7) μm, smooth, usually with inconspicuous, hyaline polar caps.

On numerous grasses in different genera. Cosmopolitan.

According to Zundel (1953:169) also on *Panicum microcarpon* Muhl. ex Ell., Spain. However, *P. microcarpon* is a North American, not European species (see Tutin *et al.*, 1980, Flora Europaea 5, and Hitchcock, 1950:650).

34. *Ustilago ignota* Vánky, **sp. nov.**

> Typus in matrice *Panicum* sp., Zimbabwe, communicavit A. Rothwell, 2.IX.1955, ut *Ustilago crus-galli*, MR 13381. Holotypus IMI 61014; isotypus HUV 19022!
>
> *Sori* quasi intumescentiae bullatae, elongatae, subepidermales, a nodis culmorum incrassatorum incipientes, usque 4 cm longi et propter coalescentiam usque 1 cm lati, culmos circumdantes. Fungus etiam ramulos scopiformes (scopas magorum) ad internodia surculorum prolificantium cum foliis brevibus congestis producens, soros bullatos, parvos, subepidermales ad basin foliorum nonnullorum patefaciens. Epidermide obtegenti in maturite rupto massam sporarum brunneam, semiagglutinatam usque pulveream ostendentes. *Sporae* globosae, subglobosae usque ellipsoidales, magnitudine variae, 5-8(-9) x 5,5-11(-12) μm, globosae vel subglobosae earum diametro 5,5-9,5 μm, flavidobrunneae usque pallide rubrobrunneae; pariete aequali, cca. 0,5 μm crasso, sparse, conspicue, humiliter echinulato; imago obliqua sporarum undulata usque subtiliter, sparse serrulata.

Sori (Fig. 12) as bullate, elongate, subepidermal swellings on thickened stems, starting from the nodes, up to 4 cm long and by confluence up to 1 cm wide, surrounding the stem. The fungus also produces witches' brooms at the nodes of proliferating shoots with short, congested leaves, presenting small, bullate, subepidermal sori at the base of some leaves. The covering epidermis ruptures at maturity disclosing the brown, semiagglutinated to powdery mass of spores. *Spores* (Figs. 18, 19) globose, subglobose to ellipsoidal, variable in size, 5-8(-9) x 5.5-11(-12) μm, globose or subglobose spores 5.5-9.5 μm in diameter, yellowish- to pale reddish-brown; wall even, c. 0.5 μm thick, sparsely, evidently, low echinulate, spore profile wavy to finely, sparsely serrulate.

On *Panicum* sp.; S. Africa. Known only from the type collection.

Very young spores resemble sterile cells. They are hyaline, globose or ovoid, often with a narrowing end, about the size of the spores, usually with a globose body (nucleus?). However, traces of and even differentiated warts or spines on still hyaline or subhyaline spores reveal their identity.

Etymology: from Latin ignotus, -a, -um = unknown

35. *Ustilago panici-petrosi* H. & P. Sydow, 1916:73.

Sporisorium panici-petrosi (Syd. & P. Syd.) M. Piepenbring, 2003:122. — Neotype on *Panicum petrosum*, Venezuela, Amazonas, Kata, Rio Cuquenan, XII.1909, E. Ule 3331, (designated here) S!

Sori destroying the whole inflorescence, elongated, 4-5 mm wide, up to 10 cm long, first covered by a pale brown peridium which ruptures irregularly disclosing the dark brown, powdery mass of spores and numerous filiform columellae formed of vascular bundles and fungal filaments. The columellae are connected with each other by thin, structureless remnants of host origin, forming a peculiar network. *Spores* variable in shape and size, globose, subglobose to usually ovoid or ellipsoidal, (6.5-)7-10(-11) x (7-)8-12(-14) μm, yellowish-brown, lighter coloured on one side; wall 0.7-1 μm thick on the darker side, thinner (c. 0.5 μm) on the lighter side, minutely, densely punctate-verruculose, spore profile smooth. *Sterile cells* absent.

On *Panicum petrosum* Trin.; S. America (Venezuela). Known only from the type collection.

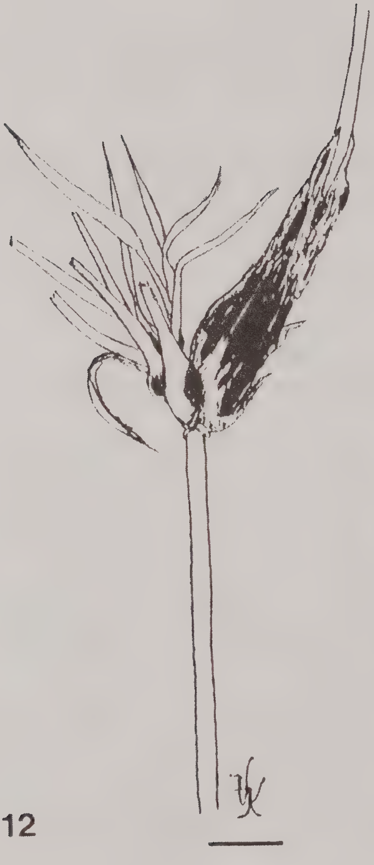
The holotype of *U. panici-petrosi* was lost in Berlin (B), during World War II. Therefore, the isotype, preserved in Stockholm (S), is designated as neotype.

The generic position of this fungus is somewhat uncertain. Based on the presence of a peridium and of (peculiar) columellae, Piepenbring (2003:122) placed it into the genus *Sporisorium* (characters which fit well with this genus). Other characters of *Sporisorium*, such as spore balls and sterile cells, are lacking. This would not be decisive, because there are many *Sporisorium* species in which the spore balls are ephemeral, and sterile cells are also lacking. However, the manner of the spore formation in this fungus is of *Ustilago*-type. Namely, the spores are formed within the cells of the septate sporogenous hyphae which swell successively, become rounded, and a chain of spore initials appears. The spore initials increase in size, become pigmented, and the thick-walled spores develop. In true *Sporisorium* species, the sporogenous hyphae concentrate into groups forming loose or permanent spore balls (comp. Langdon & Fullerton, 1975). For my generic decision, the spore wall morphology was also decisive. Spores with thinner wall on one half are typical for numerous species of *Ustilago* but not for *Sporisorium*.

36. *Ustilago panici-proliferi* Hennings, in Holway, 1899:274.

Type on *Panicum proliferum* var. *acuminatum* (= *P. succosum* Hitchc. & Chase; comp. Zundel, 1953:188), Mexico, Urbena Prov., near Mexico City, 10.X.1898, E.W.D. Holway; isotypes in Sydow, Ust. no. 212, HUV 4310!

Sori on the top of sterile shoots on and around the distal nodes, comprising also the basal part of the uppermost leaf sheaths, cylindrical with acute tip, 0.3-0.8 x 3-6 cm, first covered by a thin, ashy-grey membrane of host epidermis which early flakes away disclosing the powdery mass of spores surrounding a stout, narrowing central columella of host origin. *Spores* globose, ovoid or ellipsoidal, (6.5-)7-9 x 7.5-9.5 μm, medium dark yellowish-brown; wall even, 0.5-0.8 μm, apparently smooth to very finely, densely



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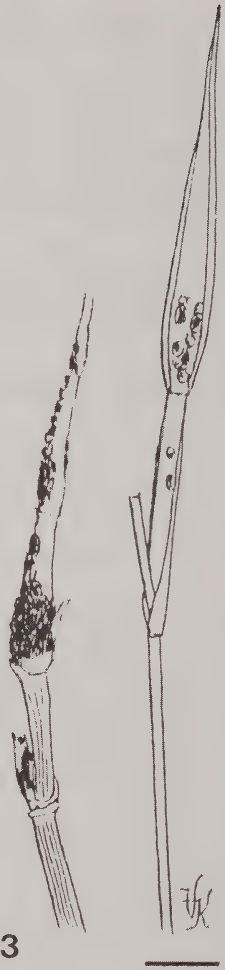

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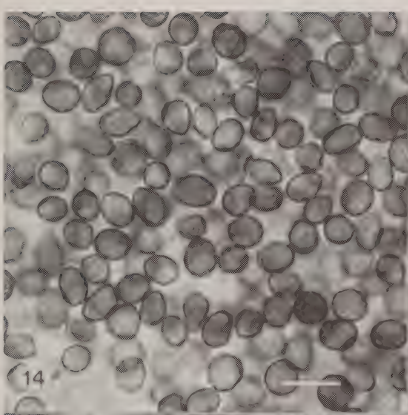
Fig. 12. Sori of *Ustilago ignota,* producing pustules on a swollen stem and also a witches' broom at the node of Panicum sp. (type).

Fig. 13. Sori of *Ustilago perirregularis,* producing pustules on the stem, leaves and leaf sheaths of *Panicum dichotomiflorum* (type). Bars = 1 cm.

Figs. 14, 15. Spores of *Sporisorium panici-hirticaulis* on *Panicum hirticaule,* in LM and in SEM (type).

Figs. 16, 17. Spores and sterile cells of *Tilletia mexicana* on *Panicum hallii,* in LM and in SEM (type).

Figs. 18, 19. Spores of *Ustilago ignota* on *Panicum* sp., in LM and in SEM (type). Bars = 10 μm.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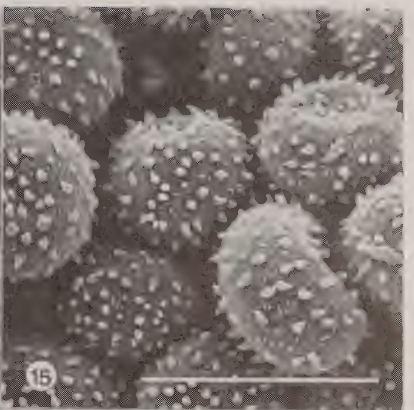
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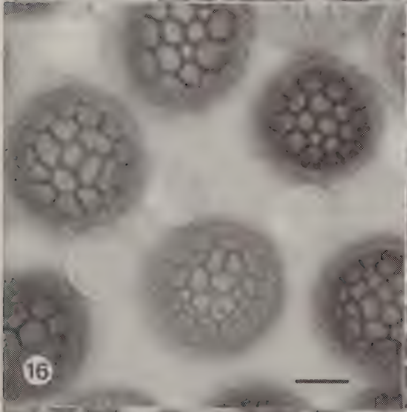
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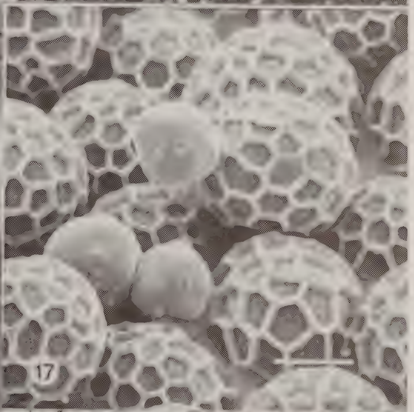
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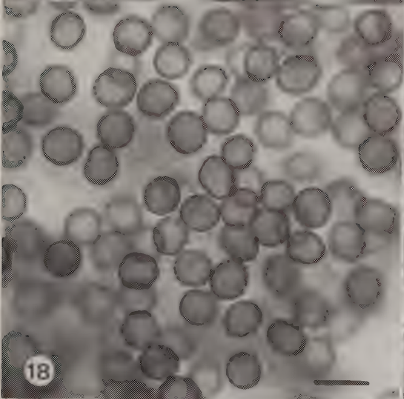
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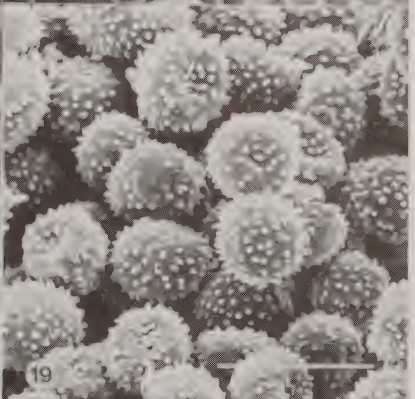
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punctate, spore profile smooth, in SEM finely, densely low echinulate. *Sterile cells* absent.

On *Panicum succosum* Hitchc. & Chase (as *P. proliferum* Lam. var. *acuminatum* Michaux, nom. herb.), *P. geminatum* Forsk. (as *P. paspaloides* Pers.); N. America (Mexico).

Surprisingly, Piepenbring (2003:180) considered *Ustilago panici-proliferi* to be a synonym of *U. paspali* Spegazzini (1899:209), type on *Paspalum* sp., Argentina, near Tucumán, I.1895, C. Spegazzini. The type specimen of *U. paspali* apparently no longer exists. According to the short original description, the sori destroy the ovaries and glumes, the spores are small, compressed, in frontal view discoid, in lateral view concave-convex (6-7 μm in diam., 2-2.5 μm wide). This description does not fit with that of *Ustilago panici-proliferi*. Additionally, the host plants belong to different genera.

37. *Ustilago panici-virgati* Vánky, 2004c:186.

Type on *Panicum virgatum*, Mexico, Mexico State, 18 km N of Atlacomulco, hwy no. 55, 19°54‘25“ N, 99°51‘01“ W, alt. 2522 m., 13.XI.2003, T. & K. Vánky, HUV 20530; isotypi in Vánky, Ust. exs. n. 1228.

Sori on the top of sterile shoots and at the uppermost nodes in hypertrophied, proliferating leaves, 1-4 mm wide, 5-15 cm long, appearing as long, coalescent striae on the leaves or comprising the distal part of the leaves or the whole, especially uppermost leaves, first covered by the epidermis which ruptures at maturity, the dark brown, semiagglutinated to powdery mass of spores is dispersed and the leaves become shredded and twisted. Rarely, the sori may appear in the inflorescence where the floral organs are transformed into narrow, elongated leaves filled with spores. *Spores* globose, subglobose, ellipsoidal to slightly irregular, laterally slightly compressed (6.5-9 μm wide), 10.5-13(-13.5) × 11-14(-15) μm, yellowish-brown; wall even, c. 1 μm thick, moderately densely echinulate, spines 0.5-0.8 μm high, spore profile serrate. *Sterile cells* absent.

On *Panicum virgatum* L.; N. America (Mexico). Known only from the type collection.

38. *Ustilago perirregularis* Vánky, **sp. nov.**

> Typus in matrice *Panicum dichotomiflorum*, USA, Nebrasca, Lincoln, 5.XI.1898, leg. J.L. Sheldon (sub *Ustilago pustulata*). Holotypus HUV 16298!
>
> *Ustilago perirregularis* ab *U. pustulata* Tracy & Earle, *Bull. Torrey Bot. Club 22*:175, 1895:175 (= *U. togata* Liro, 1924:183; type on *Panicum dichotomiflorum*, USA), praecipue distincta soris in culmis et foliis evolutis, deinde sporis extreme irregularibus, sed sori *Ustilaginis togatae* se in spiculis contentinentes et sporae eius magis regulares.

Sori (Fig. 13) on stems, branches of the panicle, leaves and leaf sheaths as bullate, subepidermal pustules, or by confluence nodular swellings, several cm long, single pustules 0.5-3(-5) mm long, at first covered by a thick, dark brown, smooth peridium of host origin which ruptures irregularly at maturity, disclosing the brown, semiagglutinated to powdery mass of spores. *Spores* (Figs. 23, 24) extremely irregular, varying in shape and size, globose, ellipsoidal, polyangular, triangular, elongated, bent, with rounded swellings or narrowing, subacute ends, wavy margins; hardly two identical spores can be seen in an optical field, 6.5-11 x 7-13.5(-17.5) μm, pale yellowish-brown; wall even,

c. 0.5 μm thick, moderately densely, finely punctate to verruculose or echinulate, spore profile smooth to finely wavy.

On *Panicum dichotomiflorum* Michaux (*P. proliferum* Lam.); N. America (USA).

Starting with Tracy & Earle (1895:175), describing *Ustilago pustulata*, North American mycologists considered the smut on the stems and leaves of *Panicum dichotomiflorum* to be *U. pustulata* (= *U. togata* Liro). Both *U. togata* and *U. perirregularis* are parasitising the same host plant species, often occurring concomitantly on the same host plant, but *U. togata* in the spikelets, *U. perirregularis* on the stems and leaves. The presence of a thick, smooth, brown peridium around the sori, and the colour of the spore masses are very similar in both these species but the spore morphology differentiates them well.

Etymology: from Latin perirregularis, -e = extremely irregular, referring to the spores.

39. *Ustilago togata* Liro, 1924:183.

Nom. nov. pro *Ustilago pustulata* Tracy & Earle, 1895:175 (not (DC.) Winter, 1880). — Type on *Panicum proliferum* Lam., USA, Miss., Starkville, X.1894, S.M. Tracy. Topotype: X.1895, S.M. Tracy, in Ell. & Ev., S. Amer. Fgi. no. 3339, HUV 9234! (syn. by Fischer, 1953:266).

Sori in some flowers of an inflorescence, often two in a spikelet, globoid, ellipsoidal to irregular, 1-2.5 x 1-3 mm, rarely as pustules on leaves or stems, at first covered by a thick, smooth, brown peridium of host tissue which ruptures irregularly at maturity disclosing the olive-brown, powdery mass of spores. *Spores* subglobose, usually ellipsoidal, ovoid or elongated to slightly irregular, 7-10.5 x 8-13 μm, yellowish-brown; wall even, c. 0.5 μm thick, finely, moderately densely low echinulate, spore profile finely wavy.

On *Panicum dichotomiflorum* Michaux (*P. proliferum* Lam.), *P. virgatum* L.; N. America (USA).

In spore morphology *Ustilago togata* is close to *U. heterogena* Henn. (type on *Leptochloa virgata*, Brazil), with which it was merged by Fischer (1953:266). However, in *U. heterogena* the spores are somewhat larger (9-13.5(-15) μm long), darker, more variable in shape, the spore wall is thicker (c. 1 μm), and more prominently echinulate than in *U. togata*. The host plants belong to different subfamilies: *Leptochloa* in *Chloridoideae*, *Panicum* in *Panicoideae*.

40. *Ustilago vastatoria* Massee, 1911:224.

Type on *Panicum* sp., French W. Africa [Lower Sahara in C. Africa; = Chad], Baghirmi between Massema and Abongher, 29-31.VIII.1903, A. Chevalier 9638, K; isotype BPI 194458!

Sori on the base of peduncles, leaf sheaths and leaf blades, forming bullate to elongate swellings, first covered by a hispid membrane of host origin which ruptures irregularly disclosing the dark brown, semiagglutinated to powdery mass of spores. *Spores* globose, subglobose, ovoid, ellipsoidal, rarely slightly irregular, 10-13 x 12-15(-17) μm, pale yellowish-brown; wall even, c. 1 μm thick, sparsely to moderately densely, evidently echinulate, spore profile serrulate.

On *Panicum* sp.; C. Africa. Known only from the type collection.

The sori of *Ustilago vastatoria* resemble those of *U. trichophora* (Link) Körn., from which it differs especially by the much larger spores. Spores of *U. trichophora* measure 6-11 x 7-12 μm. The host identity of *U. vastatoria* could not be verified as healthy plants are lacking in the isotype collections.

Species of uncertain generic position

41. „*Entyloma*“ *speciosum* J. Schröt. & Henn., in Hennings, 1896:220.

Type on *Panicum* sp., Brazil, St. Catharina Prov., near Tubarão, II.1889, E. Ule 1338, HBG; isotype in B.

According to Fischer (1953:86) it is a synonym of *Entyloma dactylidis* (Pass.) Cif. (= *Jamesdicksonia dactylidis* (Pass.) R. Bauer, Begerow, A. Nagler & Oberw.).

On *Panicum flavidum* Retz., *P. dichotomiflorum* Michaux (*P. proliferum* Lam.); S. Asia (India), *Panicum* sp.; N. America (USA), S. America (Brazil).

No specimen of „***Melanotaenium***“ ***brachiariae*** Viégas var. ***montanae*** Thirumalachar & Pavgi (1968(1969):252) is available for study. The type was described on *Panicum montanum* Roxb., India, Bihar, at Parasnath, 25.II.1955, A.S. Yadav 1254. It is not in HCIO or IMI. According to the original description the spores are irregularly globoid to poyhedral, measuring 5-12.9 μm in diameter. The wall is thick and smooth.

Key to the smut fungi of *Panicum*

(*M.* = *Macalpinomyces*; *S.* = *Sporisorium*; *T.* = *Tilletia*; *U.* = *Ustilago*)

1. Spores associated with Y-shaped conidia .... ***Conidiosporomyces ayresii***
— Spores not associated with conidia 2
2. Sori as dark spots on the leaves. Spores embedded in the host tissues 3
— Sori and spores not so 4
3. Spores 8-14(-16) μm long, wall 1-3 μm thick .... ***Eballistra brachiariae***
— Spores 6-15(-20) μm long, wall 1-2 μm thick .... “***Entyloma***” ***speciosum***
4. Sori forming witches’ brooms and/or swellings on stems 5
— Sori not so 7
5. Spores on the leaf surface, reticulate, 17-24 μm long .... ***T. tumefaciens***
— Spores subepidermal, verrucose or finely echinulate, smaller 6
6. Spores extremely irregular, 7-13.5(-17.5) μm long .... ***U. perirregularis***
— Spores rather regular, 5.5-11(-12) μm long .... ***U. ignota***
7(4) Sori on the surface of distal internodes .... ***Tranzscheliella hypodytes***
— Sori not so 8
8. Sori in the ovaries. Spores over 15 μm long 9
— Sori in various parts of the host. Spores less than 15 μm long 19
9. Sori in all ovaries of an inflorescence .... ***T. maclaganii***
— Sori in some ovaries of an inflorescence 10
10. Sori much hypertrophied, up to 20 mm long, hispid .... ***T. vittata***
— Sori only little or not hypertrophied, up to 5 mm long, not hispid 11
11. Spores reticulate 12
— Spores otherwise ornamented 14

12. Spores 25-29 μm long .... ***T. mexicana***
— Spores up to 26 μm long 13
13. Meshes per spore diam. 3-5, muri 1.5-2.5 μm high .... ***T. courtetiana***
— Meshes per spore diam. 4-6, muri 1-1.5 μm high .... ***T. narasimhanii***

14. Spores with long, filiform warts, agglutinated into groups ...... ***T. narayanaraoana***
— Spores with coarser, acute, blunt or flattened warts, not agglutinated into groups 15

15. Spores 20-29.5 μm long .... ***T. pulcherrima***
— Spores smaller, between 16 and 27 μm long 16

16. Spores very pale, warts acute, coarse, pyramidal, 19-25 on the equatorial circumference .... ***T. verrucosa***
— Spores not very pale, spines not pyramidal, more on the circumference 17

17. Warts 1-1.5(-2) μm high, 9-13 per spore diameter, 30-50 on the equatorial circumference .... ***T. biharica***
— Warts higher, less per spore diameter and on the circumference 18

18. Warts coarse, blunt, 1.5-3 μm high, 5-10 per spore diameter, 21-30 on the equatorial circumference .... ***T. banarasae***
— Warts narrower, acute, subacute or flattened, 1.5-2.5 μm high, 7-12 per spore diameter, 26-37 on the equatorial circumference .... ***T. panici-humilis***

19(8). Sori in the whole inflorescence, or in leaves on top of sterile shoots 20
— Sori in the spikelets, flowers or ovaries 31

20. Sori on the top of sterile shoots, in leaves or leaf sheaths 21
— Sori in the whole inflorescence 24

21. Spore balls present .... ***S. panici-leucophaei***
— Spore balls absent 22

22. Spores 7.5-9.5 μm long, finely, densely punctate .... ***U. panici-proliferi***
— Spores 11-15 μm long, echinulate 23

23. Sori in hypertrophied leaves, without peridium. Spines 0.5-0.8 μm high .... ***U. panici-virgati***
— Sori on base of peduncles and leaf sheaths, peridium hispid. Spines c. 0.5 μm high .... ***U. vastatoria***

24(20). Spores 8-14 μm long 25
— Spores smaller 30

25. Spores with several lighter areas .... ***S. hodsonii***
— Spores lighter only on one side or uniformly pigmented 26

26. Spores lighter on one side, where the spore wall is thinner 27
— Spores uniformly pigmented, wall even or slightly unevenly thick 28

27. Sori globoid, 3-5 mm long, with an acute tip. Spores finely verrucose-echinulate .... ***S. vesiculosum***
— Sori elongate, 3-10 cm long. Spores minutely punctate-verruculose .... ***U. panici-petrosi***

28. Spores in LM smooth .... ***S. destruens***
— Spores in LM ornamented 29

29. Spores 8-12 µm long, densely punctate-verruculose .... ***S. scheffleri***
— Spores 10.5-13.5 µm long, densely low echinulate .... ***S. panicicola***
30(24). Spores 5.5-7 µm long, nearly smooth to finely, sparsely punctate .... ***S. formosanum***
— Spores 6.5-9.5 µm long, finely, densely punctate-verruculose .. ***S. tanganykeanum***
31(19). Sori in some ovaries, flowers or spikelets of an inflorescence 32
— Sori in all ovaries, flowers or spikelets of an inflorescence 36
32. Sori in some flowers or spikelets of an inflorescence (in *U. togata* rarely also as pustules on leaves and stems) 33
— Sori in some ovaries of an inflorescence 35
33. Sori horn-shaped or cylindrical, 5-40 mm long. Spores prominently echinulate .... ***M. pretoriensis***
— Sori globoid to ovoid, 1-2 mm long. Spores finely verrucose-echinul. 34
34. Columella and sterile cells present. Spores 5.5-9.5(-12) µm long .... ***S. panici-hirticaulis***
— Columella and sterile cells absent. Spores 8-13 µm long .... ***U. togata***
35(32). Sterile cells 11-17 µm long .... ***M. sharmae***
— Sterile cells 6-11 µm long .... ***M. spermophorus***
36(31). Sori globoid, 1-1.5 mm in diam., with acute tip .... ***M. panici***
— Sori not so 37
37. Sori 1-15 mm long. Spores 8-10.5 µm long .... ***S. cryptum***
— Sori 2-4(-5) mm long. Spores larger 38
38. Spores echinulate 39
— Spores apparently smooth to finely punctate-verruculose 40
39. Spores finely, densely echinulate, 8.5-11(-12) µm long .... ***S. ovarium***
— Spores prominently low echinulate, 11-14 µm long .... ***S. panici-fasciculati***
40. Spore wall c. 0.5 µm thick, in LM smooth. Spores 9-12(-13) µm long. Columellae 3 .... ***S. spegazzinii***
— Spore wall 0.4-1 µm thick, in LM finely punctate. Spores 8.5-14.5 µm long. Columella 1 .... ***S. nyasalandicum***

The identity of *Ustilago ugandensis* and its host plant

Hennings (1895:48) described *Ustilago ugandensis* on „*Panicum* sp." from Uganda. Types in B (Berlin) and BPI (Beltsville). Unfortunately, no healthy plants are attached to the type specimens. Borrowing the collections from B, Prof. H. Scholz told me that the host plant could be a *Digitaria* sp., considered at the time of collection as *Panicum*. Indeed, study of *U. ugandensis* revealed that it is identical with „*Sphacelotheca*" *dolichosora* Ainsw., type on *Digitaria* "*longiflora*". Study of the type specimens and rich collections made in Uganda in 2002, resulted in a new combination, a synonymy and a change of host plant names.

Sporisorium ugandense (Henn.) Vánky, **comb. nov.**

Basionym: *Ustilago ugandensis* Hennings, in Engler, Pflanzenwelt Ost-Afrikas, etc., C:48, 1895. —Type on „*Panicum* sp." (= *Digitaria abyssinica* (A. Rich.) Stapf, teste K. Vánky), Uganda, Menjo, 24.XII.1890, Stuhlman 1290, B!; isotypes in B!, BPI 189128!

Sphacelotheca dolichosora Ainsworth, 1941:94. —*Sporisorium dolichosorum* (Ainsw.) Vánky, 1999:142. —Type on *Digitaria longiflora* (Retz.) Pers. (= misnamed *D. abyssinica* (A. Rich.) Stapf, teste K. Vánky*), Uganda, Entebbe, II.1930, L.C.C. Liebenberg, IMI 44763!, originating from Herb. Dept. Agricult. Uganda no. 1078, which seems to be lost. (syn. nov.).

*In the type locality of *S. dolichosora* both *Digitaria longiflora* and the rather similar *D. abyssinica* are growing but always only *D. abyssinica* was infected.

Sori destroying the distal part of sterile shoots transforming them into long linear, curved and distorted, narrowing bodies, 0.5-2 mm wide, 4-11 cm long, partly hidden by the uppermost leaf sheath, at first covered by the thin, grey host epidermis which disintegrates from the apex to expose the dark brown, semiagglutinated to dusty mass of loose spore balls and spores destroying the parenchymatic host tissues leaving intact the vascular fascicles as numerous (6 or more) filiform columellae. The sori mature from their apex where only fascicles of vascular bundles may be present whereas the basal part of the sori is still immature. *Spore balls* globose, ovoid, ellipsoidal, elongated or slightly irregular, 30-50 x 30-65(-80) μm, reddish-brown, composed of 20-80 (or more?) easily separating spores. *Spores* globose, ovoid, ellipsoidal to usually rounded subpolyhedrally irregular, 7-9.5 x 7-12 μm, yellowish-brown; wall uniform, c. 0.5 μm thick, finely, moderately densely punctate-verruculose which does not or only just affect the spore profile. *Sterile cells* lacking. Few hyaline cells in some collections probably are immature spores.

On *Poaceae*: *Digitaria abyssinica* (A. Rich.) Stapf, *D. diffusa* J. Vickery; C. Africa (Kenya, Uganda), Australia.

In the rather brief original description of *Ustilago ugandensis*, the size of the spores is given as 5-7 x 6-8 μm. I measured 7-10.5 x 8-12 μm for spores of the type, 6.5–9.5 x 7–11 μm for other collections.

New species

A new *Anthracoidea* on *Carex blanda* (*Cyperaceae*)

Since the papers of Kukkonen (1963, 1964a, b, 1969), Nannfeldt (1977, 1979), Nannfeldt & Lindeberg (1957, 1965), and Vánky (1979), it gradually became evident that the c. 80 known species of *Anthracoidea* form a natural group, parasitising members of *Cyperaceae* (*Carex*, *Carpha*, *Fuirena*, *Kobresia*, *Schoenus*, *Scirpus*, *Trichophorum*, *Uncinia*). Most of them are morphologically only slightly but consistently different “small species”, adapted to one or several host plant species which belong to the same or closely related sections (for the 50 European species see Vánky, 1994; comp. also Vánky, 2002b:28-29).

Carex blanda Dewey belongs to the subgenus *Indocarex*, sect. *Careyanae*. Kükenthal (1909:526) treated it as *Carex laxiflora* Lam. var. *blanda* (Dewey) Boott. In the sect. *Careyanae*, Kükenthal (1909) enumerated thirteen *Carex* species. Of these, a smut fungus is known on *C. siderosticta* Hance (*A. siderostictae* Kukkonen, from Japan) and on *Carex blanda* Dewey (*Cintractia caricis* (Pers.) Magn., = *A. caricis* (Pers.) Bref., from USA). Study of the *Carex blanda* collections in the R.L. McGregor Herbarium

(KANU, University of Kansas, Lawrence, Kansas, USA), as well as of newly collected specimens, showed that many are infected by an unknown *Anthracoidea* species which is described as:

Anthracoidea blanda Vánky & H. Alexander, **sp. nov.**

Typus in matrice *Carex blanda* Dewey (det. C. Morse), USA, Kansas, Douglas Co., 3 km N urbe Baldwin, Breidenthal Biological Reserve, 38°48'37" N, 95°11'25" W, alt. 288 m.s.m., 31.V.2004, leg. H. Alexander, det. K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 20759!; isotypi in BP, BPI, IMI, KANU 326168 et in Vánky, Ust. exs. no. 1249. Paratypi: Douglas Co., 4.VI.1995, leg. C.A. Morse 277, HUV 20570!, KANU 13198; Saline Co., 7 km SE urbe Salina, Hagg Place, 1.VI.2004, leg. S. Cox, HUV 20761!

Anthracoidea blanda differens ab *A. siderostictae* Kukkonen, Ann. Bot. Fenn. 1:174, 1964a (typus in *Carex siderosticta* Hance, Japan) sporis irregularibus, (12-)14,5-18,5(-20) x (14-)16-22,5(-24) μm magnitudine; pariete sporarum inaequali, (0,5-)1-2,5(-3) μm crasso, saepe cum protuberationibus, cum tumoribus internis infirme usque bene evolutis et raro etiam maculis lucem refringentibus.

Sori (Fig. 20) in some ovaries of an inflorescence forming globose to ovoid, hard, black bodies around the nutlets, 1.5-2 mm in diameter, partly hidden by the glumes, at first covered by a thin, greyish, fungal membrane which early dehisces disclosing the black, agglutinated mass of spores with powdery surface. *Spores* (Figs. 25, 26) small, flattened, in side view 9-11 μm, in plane view subcircular, broadly elliptic, subpolygonal, usually irregular, (12-)14.5-18.5(-20) x (14-)16-22.5(-24) μm, medium dark reddish-brown; wall uneven, often with protuberances, (0.5-)1-2.5(-3) μm thick, thickest at the angles and protuberances, internal swellings weak to well-developed, rarely light-refractive spots may be present, surface finely, rather densely verruculose, warts unevenly spaced, few or several may fuse forming short rows or an irregular pattern, spore profile finely wavy.

On *Cyperaceae*: *Carex blanda* Dewey; N. America. Known from numerous places in the USA (Indiana, Kansas).

Despite the uniformity, there are some variations between different collections regarding size of the spores, thickness of the spore wall, the protuberances and the internal swellings. These are considered variations within the same species.

Anthracoidea blanda differs from *A. siderostictae*, in which the spores are more regular, larger (18-26 μm long), lighter coloured, the spore wall is evenly thickened (c. 1.5 μm), the spore surface is coarsely verrucose, and protuberances, light refractive areas and internal swellings are lacking.

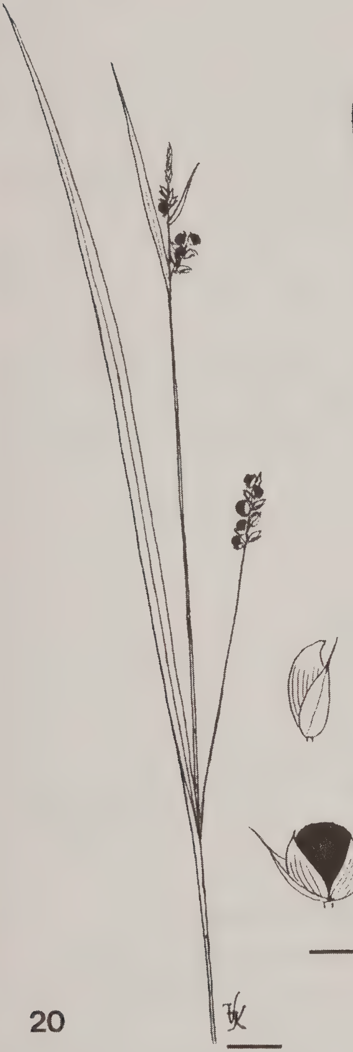
A new *Entyloma* on *Bergenia* (*Saxifragaceae*)

Describing *Taphrina bergeniae* Döbbeler (1978) observed *Entyloma*-like spores in some leaves of ornamental *Bergenia* species, collected by his wife. The material was sent to me for further investigation. It turned out that it is a new species:

Entyloma bergeniae Vánky & Döbbeler, **sp. nov.**

Typus in matrice *Bergenia* sp. cult., Germania, Niedersachsen, Göttingen, Rohnsweg 22, 51°02'12.1" N, 9°56'56.4" E, alt. 196 m, 1.V.1986, leg. G. Döbbeler. Typus in Herb. Ustil. Vánky, HUV 20666.

Sori in foliis maculas pallidas, parum tumefactas, rugosas, irregulares formantes, 0,5-3 cm, vel coalescentes longiores. *Sporae* in telia foliorum inclusae, dispersae vel agglomeratae,



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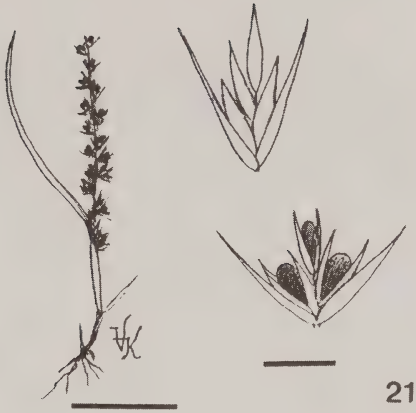

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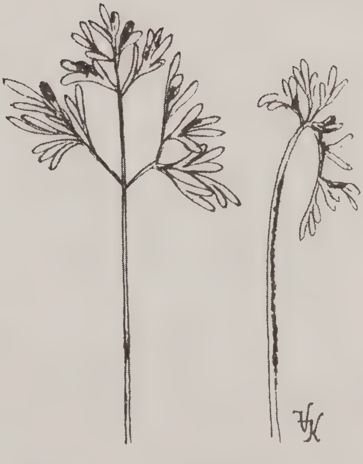

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Fig. 20. Sori of *Anthracoidea blanda* around some nutlets of an inflorescence of *Carex blanda* (type). Habit, and enlarged a sorus and a healthy spikelet.

Fig. 21. Sori of *Tilletia lolioli* in the ovaries of *Loliolum subulatum* (type).

Fig. 22. Sori of *Urocystis beckwithiae* on the leaves and petioles of *Beckwithia andersonii* (type).

Bars = 1 cm for habit, and 2 mm for the detail drawings.

globosae, subglobosae, usque propter pressum mutuum earum parum irregulares, 8-12 x 9-12 μm, pallide flavidobrunneae; pariete aequali, 0,8-1,2 μm crasso, levi, saepe vestigium hyphae sporogenae breve, 2-2,5 μm latum, apice rotundo et in latere opposito sporae papillam minutam gerentes. *Anamorpha* non observata.

Sori on the leaves, forming paler, slightly swollen, crinkly, irregular leaf spots, 0.5-3 cm, or longer by confluence. *Spores* (Fig. 27) embedded in the leaf tissue, scattered or agglomerated, globose, subglobose to slightly irregular by mutual pressure, 8-12 x 9-12 μm, pale yellowish-brown; wall even, 0.8-1.2 μm thick, smooth, often bearing a short, 2-2.5 μm wide remnant of the sporogenous hypha, with rounded top, and a minute papilla on the opposite side of the spore. The spores are produced on the top of sporogenous hyphae in the intercellular spaces of the parenchymatic host tissue. Concomitantly with mature spores also thin-walled, hyaline, small spore initials or very young spores are present. *Anamorph* not seen.

On *Saxifragaceae*: *Bergenia* sp. cult.

On members of *Saxifragaceae* two further *Entyloma* species are known: **1.** ***E. chrysosplenii*** J. Schröter (in Cohn, 1877:372), type on *Chrysosplenium alternifolium* L., Germany, and **2.** ***E. lithophragmae*** G.W. Fischer & C.G. Shaw (in Fischer, 1952:4), type on *Lithophragma parviflora* (Hooker) Nutt., USA. *E. bergeniae* differs from both these species. A fourth species, ***E. schinzianum*** (Magnus) Bubák (1906:107), type on *Saxifraga rotundifolia* L., Austria, is actually *Exobasidium warmingii* Rostrup.

In *Taphrina bergeniae* Döbbeler the infected leaves are yellowish- or olivaceous-green and dull. Hyphae, ascogenous cells and asci develop subcuticularly and may cover the whole leaf surface. The leaves are often deformed, cup-shaped.

Key to the *Entyloma* species of *Saxifragaceae*

1. Sori orbicular, thin, often perforated. Anamorph present. Spore wall 0.5-1 μm thick. On *Chrysosplenium* . . . . ***E. chrysosplenii***

— Sori slightly swollen, not perforated. Anamorph absent. Not on *Chrysosplenium* 2

2. Spores 9-12 μm long, wall even, 0.8-1.2 μm thick, often with a papilla. On *Bergenia* . . . . ***Entyloma bergeniae***

— Spores 9-19 μm long, wall often uneven, 0.5-2.5 μm thick, without a papilla. On *Lithophragma* . . . . ***E. lithophragmae***

A new *Tilletia* on *Loliolum* (*Poaceae*)

Loliolum Krecz. & Bobrov, in the subfam. *Pooideae*, tribe *Poeae*, is a unispecific genus. Its type, *L. subulatum* (*Nardurus subulatus*) occurs from the Eastern Mediterranean to central Asia (Clayton & Renvoize, 1986:97).

Some diseased plants of *L. subulatum* were discovered between healthy ones in Herb. Berlin (B), infected by a *Tilletia* species. Its study, including spore germination and molecular analyses (L. Carris, unpublished data), showed that it represents a new species:

Tilletia lolioli Vánky, Carris, Castlebury & H. Scholz, **sp. nov.**

Typus in matrice *Loliolum subulatum* (Banks & Sol.) Eig, Lebanon, Bequa'a Plain, at the Hermel Pyramids, 34°21'51" N. 36°24'57" E, alt. cca. 770 m.s.m., 24.IV.2003, leg.

> M. Ristow, comm. H. Scholz. Holotypus in B; isotypus in Herbario Ustil. Vánky, HUV 20462!
>
> *Sori* in ovariis omnibus plantae eiusdem infectae, inter involucra floralia expansa sicut corpora ovoidea vel ellipsoidalia, nigrescentibrunnea apparentes, 0,5-0,8 x 1-1,5 mm, primo pericarpio tenui cooperti, quo mature irregulariter rupto massam nigricantibrunneam, pulveream sporarum et cellularum sterilium ostendentes. *Sporae* globosae, subglobosae usque ellipsoidales, 20-24 x 21-27 μm, flavido- usque castaneobrunneae, reticulatae, maculae polyangulares, forma et magnitudine variae, 6-10 per diametrum sporae, muri 1-1,5 μm altis, in visu opticali mediano acuti, subacuti vel obtusi, 30-39 in circulo aequatoriali. *Cellulae steriles* subglobosae, ellipsoidales, ovoideae vel irregulares, 9,5-15 x 12-18 μm, hyalinae; pariete 0,5-1 μm crasso, levi.

Sori (Fig. 21) in all ovaries of an infected plant, showing between the spreading floral envelopes as ovoid or ellipsoidal, blackish-brown bodies, 0.5-0.8 x 1-1.5 mm, first covered by the thin pericarp which ruptures irregularly at maturity disclosing the blackish-brown, powdery mass of spores and sterile cells. *Spores* (Figs. 30, 31) globose, subglobose to ellipsoidal, 20-24 x 21-27 μm, yellowish- to chestnut-brown, reticulate, meshes polyangular, variable in size and form, 6-10 per spore diameter, muri 1-1.5 μm high, in optical median view acute, subacute or blunt, 30-39 on the equatorial circumference. *Sterile cells* (Figs. 30, 31) subglobose, ellipsoidal, ovoid or irregular, 9.5-15 x 12-18 μm, hyaline; wall 0.5-1 μm thick, smooth.

On *Poaceae*: *Loliolum subulatum* (Banks & Sol.) Eig (*L. orientale* (Boiss.) Krecz. & Bobrov; *Nardurus subulatus* (Banks & Sol.) Bor; *N. orientalis* Boiss.); Asia (Iran, Lebanon).

Tilletia lolioli was compared with the type of *T. bromi* and with that of *T. narduri* Nagorny (1920:24; type on *Nardurus* sp., = *Vulpia* sp.), which is considered to be *T. bromi* (comp. also Durán & Fischer, 1961:66). *T. lolioli* differs from *T. bromi* especially in having darker spores, more meshes per spore diameter, lower and more muri on the equatorial circumference.

Despite of its less typical, more variable spore morphology, but based on molecular analyses, „*T. bromi*“ on *Loliolum subulatum* from Iran (Vánky, Ust. exs. no. 763) belongs also to *T. lolioli* (L. Carris, unpublished data). It has 5-10, sometimes incomplete meshes per spore diameter and 25-35 muri on the equatorial circumference.

A new *Urocystis* on *Beckwithia* (*Ranunculaceae*)

The *Urocystis*, collected on *Beckwithia andersonii*, nearly one hundred years ago in the USA, under the name of *U. sorosporoides* Körn., turned out to be a new species:

Urocystis beckwithiae Vánky, sp. nov.

> Typus in matrice *Beckwithia andersonii* (A. Gray) Jeps., USA, Nevada, above Verdi, Morrill's Lake, 30.IV.1910, leg. A.A. Heller, HUV 16196!; isotypi in BPI 182537 et 182538. Paratypus: Morrill's Lake, above Marmol Station, alt. c. 1830 m, 2.V.1910, leg. A.A. Heller, in Plants of Newada, Washoe County, no. 10002a, HUV 13730!
>
> *Sori* in foliis et petiolis pustulas formantes, diametro 1-2 mm, vel propter confluentiam majores, structura paene polycystici, primum cinerei, epidermide cooperti, quo maturo rupto massam nigram, granuloso-pulveream glomerulorum sporarum ostendentes. *Glomeruli sporarum* globosi, ovoidei, ellipsoidales, elongati vel irregulares, 25-65 x 30-70 μm, flavido- usque rubrobrunnei, ex 1-13(-18) sporis, strato incompleto cellularum

> sterilium circumdatis compositi. *Sporae* subglobosae, ovoideae, ellipsoidales, elongatae vel subpolyedrice irregulares, cum latere uno vel lateribus nonnullis deplanatis, 11-16 x 13-22,5 µm, flavido- usque rubrobrunneae; pariete aequali, cca. 0,5 µm crasso, leniter granuloso-verruculoso. *Cellulae steriles* subglobosae, ovoideae, ellipsoidales vel parum irregulares, 5-10,5 x 5-13,5(-15) µm, flavidobrunneae, parum pallidiores quam sporae; pariete aequali usque inaequali, 0,5-2,5 µm crasso, levi, in latere libero saepe collapso.

Sori (Fig. 22) on the leaves and petioles forming pustules, 1-2 mm in diameter or larger by confluence, then of a polycystic structure, first greyish, covered by the epidermis which ruptures irregularly at maturity disclosing the black, granular-powdery mass of spore balls. *Spore balls* (Figs. 32, 33) globose, ovoid, ellipsoidal, elongated or irregular, 25-65 x 30-70 µm, yellowish- to reddish-brown, composed of 1-13(-18) spores surrounded by an incomplete layer of sterile cells (as seen in LM on rehydrated spores). *Spores* (Figs. 32, 33) subglobose, ovoid, ellipsoidal, elongated or subpolyhedrally irregular, with one or several flattened sides, 11-16 x 13-22.5 µm, yellowish- to reddish-brown; wall even, c. 0.5 µm thick, finely granular-verruculose. *Sterile cells* (Figs. 32, 33) subglobose, ovoid, ellipsoidal or slightly irregular, 5-10.5 x 5-13.5(-15) µm, yellowish-brown, slightly paler than the spores; wall even to unevenly thick (0.5-2.5 µm), smooth, often collapsed on the free side.

On *Ranunculaceae*: *Beckwithia andersonii* (A. Gray) Jeps.; N. America. Known only from the type collections.

Frequency of spores per spore ball: 1=2%, 2=5.5%, 3=13.5%, 4=13%, 5=14.5%, 6=11%, 7=14%, 8=9%, 9=5.5%, 10=5.5%, 11=1.5%, 12=1.5%, 13=1.5%, 14=0.5%, 15=0%, 16=0.5%, 17=0.5%, 18=0.5%.

Urocystis beckwithiae differs from *U. sorosporoides* Körn. ex A.A. Fisch. Waldh. (type on *Thalictrum minus* L., Germany), in which the spore balls and spores are somewhat smaller, the sterile cells form a complete or nearly complete layer around the spores, and the number of spores in the balls is 1-10(-12).

A new *Ustilago* on *Tridens* (*Poaceae*)

Tridens Roem. & Schult., with 18 species from eastern USA to Argentina, and one species in Angola, belongs to the subfamily *Chloridoideae*, tribe *Eragrostideae*, subtribe *Eleusininae* (Clayton & Renvoize, 1986:205). Only two smut fungi are known on *Tridens*: ***Ustilago buchloës*** Ellis & Tracy (see Vánky, 2004b:182), and ***U. tricuspidis*** Ellis & Galloway. A third species is:

Ustilago tridentis Vánky, **sp. nov.**

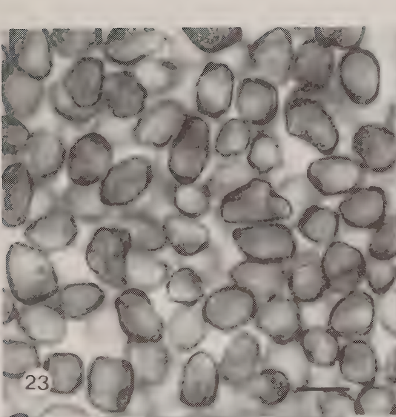
> Typus in matrice *Tridens eragrostoides* (Vasey & Scribn.) Nash, Mexico, Sonora, 37 km S urbe Guaymas, hwy no. 15, alt. 61 m.s.m., 18.X.1976, leg. R. Durán & P.M. Gray. Holotypus in Herbario Ustil. Vánky, HUV 14667; isotypus in WSP 62125 (sub *U. tricuspidis*). Paratypus ibidem, 53 km S urbe Guaymas, HUV 14668; isoparatypus in WSP 68350 (sub *U. tricuspidis*).

Figs. 23, 24. Spores of *Ustilago perirregularis* on *Panicum dichotomiflorum*, in LM and in SEM (type).

Figs. 25, 26. Spores of *Anthracoidea blanda* on *Carex blanda*, in LM and in SEM (type).

Fig. 27. Spores of *Entyloma bergeniae* on *Bergenia* sp. cult., in LM (type).

Fig. 28. A germinating spore of *Sporisorium panici-fasciculati* (type), with an 8-celled basidium on which septate hyphae and elongated basidiospores are produced. Bars = 10 µm.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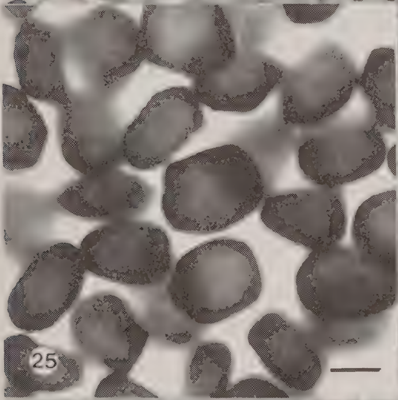
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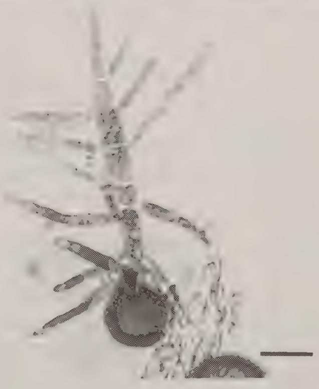
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> *Sori* in spiculis, plerumque in agminibus evoluti, nonnunquam tantum in ovario restricti, nonnunquam spiculos nonnullos requirentes, globoidei, ellipsoidales, limoniiformes vel irregulares, cum apice acuto, primum peridio flavido usque atrobrunneo saepe cum residuis involucrorum floralium internorum sicut squamis acutis cooperti. Postea peridio irregulariter rupto massam atrobrunneam, pulveream sporarum ostendentes. *Sporae* globosae, subglobosae usque late ellipsoidales, magnitudine variae, 8-12 x 9-13(-14) μm, pallide flavidobrunneae; pariete aequali, cca. 0,5 μm crasso, moderate dense, leniter verrucoso-echinulato, imago obliqua sporae levis, undulata usque leniter serrulata.

Sori (Fig. 29) in the spikelets, usually appearing in groups, sometimes restricted to the ovary only, sometimes comprising several spikelets, globoid, ellipsoidal, lemon-shaped or irregular, with acute tip, first covered by a yellowish- to dark brown peridium, often with remnants of inner floral envelopes as acute scales. Later the peridium ruptures irregularly disclosing the dark brown, powdery mass of spores. *Spores* (Figs. 34, 35) globose, subglobose to broadly ellipsoidal, variable in size, 8-12 x 9-13(-14) μm, pale yellowish-brown; wall even, c. 0.5 μm thick, moderately densely, finely verrucose-echinulate, spore profile smooth, wavy to finely serrulate.

On *Poaceae*: *Tridens eragrostoides* (Vasey & Scribn.) Nash; N. America. Known only from the type collections.

Ustilago tridentis differs from *U. tricuspidis* Ellis & Galloway (lectotype on *Tridens flavus* (L.) Hitchc., USA), i.a., in sorus and spore morphology. In *U. tricuspidis* the sori are restricted to the ovaries, the spores are smaller (7-10 x 7-11 μm), darker, and with a thicker (c. 1 μm), prominently echinulate wall.

Hyaline, rounded fungal cells in chains, observed in *U. tridentis*, are probably sporogenous hyphae.

Key to the smut fungi (*Ustilago*) of *Tridens*

1. Sori on the leaves forming bullate striae . . . . **U. buchloës**
— Sori elsewhere 2

2. Sori in the ovaries. Spores 7-11 μm long, echinulate . . . . **U. tricuspidis**
— Sori usually in the spikelets. Spores 9-14 μm long,
verrucose-echinulate . . . . **U. tridentis**

New name

The two names, *Tilletia poonensis* Thirum. & Pavgi (1967(1968):26) and *T. punensis* (S.D. Patil & Gandhe) Vánky (2001:290) are confusingly similar enough to be considered homonyms (see ICBN 53.3). Therefore, for the second species, I propose the name:

Tilletia puneana Vánky, **nom. nov.**

Based on and replacing *Neovossia punensis* S.D. Patil & Gandhe, Maharashtra Vidnyan Mandir Patrika 12:48, 1977. — *Tilletia punensis* (S.D. Patil & Gandhe) Vánky, 2001:290. — Type on *Polytoca barbata*, India, Maharashtra State, Poona (Pune), 10.XII.1975, R.V. Gandhe, D.B. Kapadnis & K.G. Date, Herb. R.V. Gandhe (Poona, India); isotype HUV 19029!

For its description see Vánky, 2001:290.

On *Poaceae*: *Polytoca barbata* (Roxb.) Stapf; S. Asia (India).

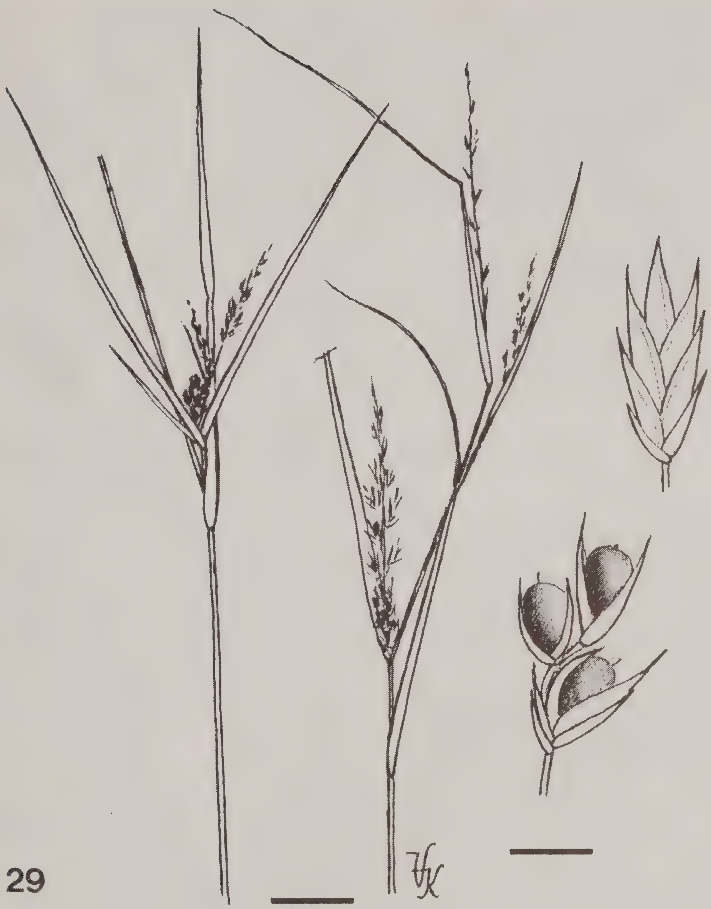


Fig. 29. Sori of *Ustilago tridentis* in the spikelets and ovaries of *Tridens eragrostoides* (type). Habit, and enlarged an infected and a healthy spikelet. Bars = 1 cm for habit, and 2 mm for the detail drawings.

New combinations

Jamesdicksonia linearis (Berk. & Broome) Vánky, **comb. nov.**

Basionym: *Gymnosporium lineare* Berkeley & Broome, J. Linn. Soc. Bot 14:90, 1875. — *Coniosporium lineare* (Berk. & Broome) Saccardo, 1886:243. — *Ustilago linearis* (Berk. & Broome) Petch, 1924:167. — *Tolyposporella linearis* (Berk. & Broome) L. Ling, 1949a:133. — *Sorosporium lineare* (Berk. & Broome) Thirumalachar, Whitehead & O'Brien, 1967:394 (as "*linearis*"). — Type on *Andropogon muricatus* (= *Vetiveria* *zizanioides*), Sri Lanka [Ceylon], Damboul, III.1868, G.H.K. Thwaites 506, PDA; isotype BPI 162517!

Sori on the leaves, forming linear, fusiform striae, 0.3-0.7 x 2-7 mm or longer by confluence, first covered by host tissue which ruptures longitudinally, mostly on the abaxial side, disclosing the black, agglutinated spore mass. *Spores* extremely variable in shape and size, subglobose to polyhedral, elongated, prismatic or lacrymiform, 6.5-13.5 x 8-40 μm, olivaceous- to reddish-brown; wall two-layered, inner layer thin, even (c. 0.5 μm), outer layer uneven, 0.5-4 or up to 8 μm thick for the acute spores, with a cracked thin surface layer of which small pieces detach easily. *Spore germination* not known.

On *Poaceae*: *Vetiveria zizanioides* (L.) Nash (*Andropogon muricatus* Retz.); S. Asia (Sri Lanka). Known only from the type collection.

Microbotryum primulae (Wettst.) Vánky, **comb. nov.**

Basionym: Ustilago primulae R. Wettstein, Oesterr. Bot. Z. 36:73, 1886. — Type on *Primula clusiana* Tausch, Austria, Nieder-Österreich, Mt. Schneeberg near Vienna, 1884, J. Schneider.

Sori in the anthers as a grey, powdery spore mass. *Spores* globose, subglobose to irregularly rounded, 11-14 x 12-18 μm in diameter, light greyish, with hyaline endospore and densely reticulate, grey exospore.

This interesting smut, in the anthers of a *Primulaceae*, certainly does not belong to the genus *Ustilago*, which occurs exclusively on *Poaceae*. It is known only from the original description. No specimen is preserved in W, and the type specimen probably no longer exists. It shows all characters of the genus *Microbotryum*, hence the new combination. Recollection is desired.

A further species of *Mycosyrinx*

Mycosyrinx Beck, in the *Mycosyringaceae* R. Bauer & Oberw., is a peculiar genus (comp. Vánky, 1996 and 2002b:110-111). It has three known species and one variety, all on *Cissus* spp. (*Vitaceae*), in the tropics and subtropics: ***M. arabica*** (Henn.) Penzig, ***M. cissi*** (DC.) Beck, and ***M. microspora*** Cant. Study of the variety resulted in its recognition at species level, as:

Mycosyrinx usambarensis (Henn.) Vánky, **comb. et stat. nov.**

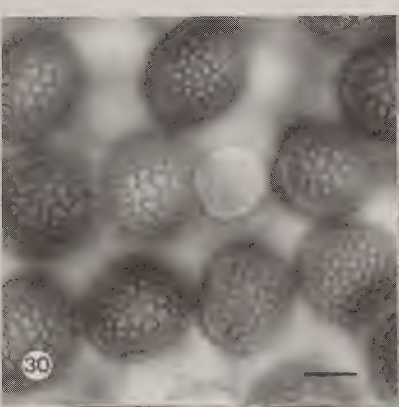
Basionym: *Schroeteria cissi* (DC.) de Toni var. *usambarensis* Hennings, in Engler, Pflanzenwelt Ost-Afrikas, etc., C:49, 1895. — Type on *Cissus* sp., tropical Africa (as "tropical America"), Usambara, Tanzania, coll. C. Holst 2422, BPI 192771!

Mycosyrinx usambarensis differs from *M. cissi* in having much thicker branches of the witches' brooms and larger spores. The spore measurements of single spores of *M.*

Figs. 30, 31. Spores and sterile cells of *Tilletia lolioli* on *Loliolum subulatum,* in LM and in SEM (type).

Figs. 32, 33. Spore balls, spores and sterile cells of *Urocystis beckwithiae* on *Beckwithia andersonii,* in LM and in SEM (type).

Figs. 34, 35. Spores of *Ustilago tridentis* on *Tridens eragrostoides,* in LM and in SEM (type). Bars = 10 μm.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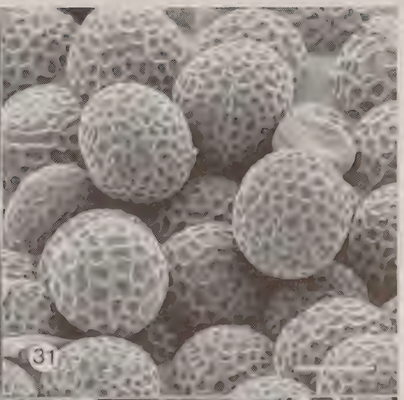
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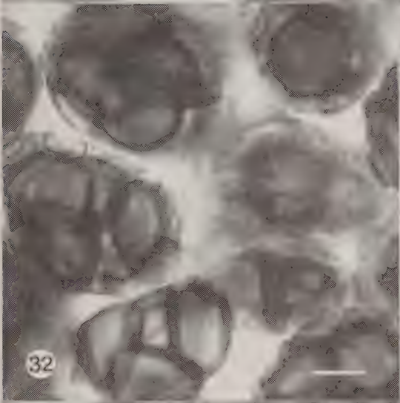
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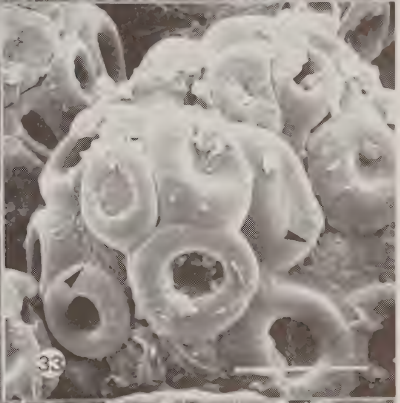
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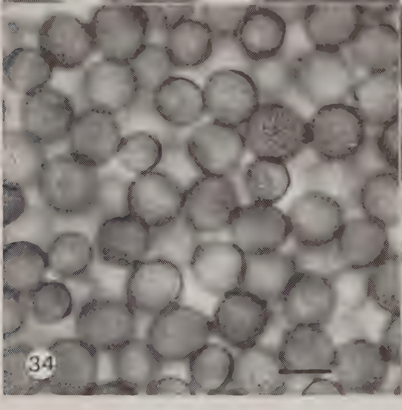
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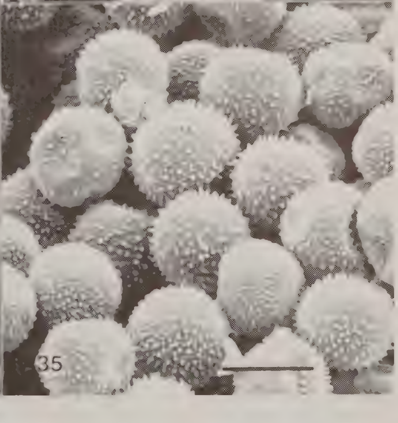
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usambarensis are: 8-10.5 μm in side view, 10.5-13.5 x 12-15 μm in face view. Those of *M. cissi* are: 7-8.5(-9) μm in side view, and 9.5-12.5 x 10.5-13.5 μm in face view.

On *Vitaceae*: *Cissus* sp.; Africa. Known only from the type collection.

Sphacelotheca eleocharidis is a *Cintractia*

In connection with a new species, I checked all members of the genus *Ustanciosporium* (Vánky, in prep.). Restudy of *U. eleocharidis* revealed characters which motivate its transfer into the genus *Cintractia* s. str.

Cintractia eleocharidis (Thirum. & Pavgi) Vánky, **comb. nov.**

Basionym: *Sphacelotheca eleocharidis* Thirumalachar & Pavgi, Sydowia 7:99, 1953. — *Ustanciosporium eleocharidis* (Thirum. & Pavgi) Vánky, 2004a:109. — Type on "*Eleocharis* sp." (= misnamed *Bulbostylis* sp., revised K. Vánky), India, Bihar, Netarhat, 2.IX.1952, M.J. Thirumalachar, HCIO 20933; isotype HUV 15510!

Sori in all or almost all flowers of each spikelet of an inflorescence, destroying the inner floral organs and surrounding them with a thick, whitish stroma on which a chocolate-brown, agglutinated mass of spores is produced. Young sori are globoid, c. 0.5 mm in diameter, covered by a fungal peridium and enclosed by the outermost glumes. At maturity, the glumes gradually fall off the plant, the peridium flakes away, disclosing the agglutinated spore masses with powdery surface. Several sori within the spikelets may fuse into a lobed body of 1-3 mm diameter. *Spores* single, flattened, in side view elliptic, 7-9 μm wide, in plane view circular, ovate, elliptic, elongated or slightly irregular, not rarely lacrymiform with an acute or subacute tip, no hyaline appendage, 8-12 x 9.5-16 μm, yellowish-brown; wall even, 0.7-1 μm thick, evidently and typically verrucose-echinulate, spore profile finely, sparsely serrulate, in SEM the warts or spines are connected by thin threads forming dense, irregular, often incomplete meshes.

On *Cyperaceae*: *Bulbostylis* sp. (as "*Eleocharis* sp."); S. Asia. Known only from the type collection.

Regarding the host plant, the branched inflorescence which is subtended by leafy bracts exclude it from *Eleocharis*. Based on the absence of hypogynous bristles and on the bulbously thickened, persistent stylebase, I consider it a *Bulbostylis* sp.

Peridia around the sori not seen. They are absent from the mature sori of the isotype specimen.

Two new combinations

Sporisorium andropogonis-schirensis (L. Ling) Vánky, **comb. nov.**

Basionym: *Sphacelotheca andropogonis-schirensis* L. Ling. Lloydia 16:181, 1953a. — Type on *Andropogon schirensis*, Congo, Bandundu, 3°20' S, 17°24' E, II.1914, H. Vanderyst 3555, BR 1349; isotypes in BPI 193953, K, HUV 18276!

Sori in all spikelets of an inflorescence, ellipsoidal, 1-1.5 x 2-3.5 mm, evident between the spreading glumes, first covered by a brown, rather thick peridium which ruptures from its apex disclosing the dark brown, semiagglutinated to powdery mass of loose spore balls, spores and groups of sterile cells, surrounding a stout, tapering columella. *Spores* when mature single, subglobose, ellipsoidal, ovoid to slightly irregular, 6.5-9 x

7-10.5(-11) µm, yellowish-brown; wall even, c. 0.5-0.7 µm thick, finely, rather sparsely to moderately densely verruculose-echinulate, spore profile in LM smooth, in SEM, between the small spines finely, densely verruculose. *Sterile cells* in irregular groups, collapsed in old specimens, single cells 7-15.5 µm long, hyaline, wall thin (c. 0.5 µm), smooth.

On *Poaceae*: *Andropogon schirensis* Hochst.; C. Africa. Known only from the type collection.

Sporisorium pseudomaranguense (Zundel) Vánky, **comb. nov.**

Basionym: *Sorosporium pseudomaranguense* Zundel, Bothalia 3:309, 1938. - Type on *Andropogon* sp. (det. A. Chase), South Africa, Natal, Mooi River, 21.III.1917, A.O.D. Mogg, PREM 10073; isotype HUV 18007!

Sori destroying the whole inflorescence, long linear, c. 2 mm wide, 3-5 cm long, hidden by the uppermost leaf sheath from which only the tips of the sori protrude, at first covered by a thick, yellowish-brown peridium which ruptures irregularly liberating the dark brown, granular-powdery mass of spore balls and groups of sterile cells surrounding numerous, long, filiform, slender columellae. *Spore balls* subglobose, ovoid, ellipsoidal, elongate or slightly irregular, 30-70 x 40-130 µm, dark reddish-brown to subopaque, composed of tens of spores which separate by pressure. *Spores* variable in shape and size, subglobose, ellipsoidal to subpolyhedrally irregular, 8-12 x 9-14.5 µm, dimorphic. Outer spores rounded, larger, dark yellowish- to reddish-brown, wall irregular, 0.8-1.2 µm thick, prominently, moderately densely verrucose-echinulate, spore profile serrulate. Inner spores subpolyhedral, smaller, pale yellowish-brown, wall even, c. 0.5 µm thick, finely punctate-verruculose. *Sterile cells* few, in irregular groups or short chains, single cells ellipsoidal to usually irregular with flattened sides, 8-12 µm long, hyaline; wall c. 0.5 µm thick, smooth.

On *Poaceae*: *Andropogon* sp.; S. Africa. Known only from the type collection.

Synonyms

Ustilago ehrhartana* is *U. dactyloctenii* on *Dactyloctenium

Zundel (1943:164) described *Ustilago ehrhartana* Zundel on "*Ehrharta erecta* Louv. var. *natalensis* Stapf", from South Africa, Natal, Ingwavuma Distr., 29.XI.1938, O. West 915. Holotype PREM 30501!; isotypes BPI 188932!, HUV 18190! Unfortunately, no healthy plants are preserved along with the smutted specimens. The sori of *Ustilago ehrhartana* are typical, and very similar to those of *U. dactyloctenii* Hennings (1895:48), type on *Dactyloctenium aegyptium* (L.) P. Beauv., Zanzibar, leg. Stuhlmann, BPI 194463! Therefore, I compared the spores of these two species. It turned out that they are identical. The vegetative parts of the infected host plants of *Ustilago ehrhartana* are also similar to those of *Dactyloctenium*, especially of *D. australe* Steud., which is often infected by *U. dactyloctenii* in South Africa. Due to the systemic infection produced by *U. dactyloctenii,* often all shoots of a population of *Dactyloctenium* are affected, without any healthy inflorescence. Probably this is the reason for the misnamed host plant of the type specimen.

Consequently, I consider *Ustilago ehrhartana* to be *U. dactyloctenii* on misnamed *Dactyloctenium* cf. *australe* Steud. (syn. nov.).

Ustilago anhweiana and *U. reticulispora* are synonyms of *Microbotryum cordae*

The floral smuts of *Polygonaceae*, possessing reticulate spores, known also under the collective name of "*Ustilago anomala*", represent a taxonomically difficult group. Numerous taxonomic and nomenclatural changes were proposed by almost every "ustilaginologist" who worked with this group (comp. Liro, 1924, Hirschhorn, 1947, Ling, 1945, 1950, Savile, 1953, Ciferri, 1959, Lindeberg, 1959, Vánky & Oberwinkler, 1994, Vánky, 1998b). The difficulty lies in the great number of described species and the small or almost non-existent morphological differences of the spores. Molecular analyses will certainly bring more clarity in the classification of this group. A first attempt was made by Guo (1996), analysing rDNA of four species of this group: *U. anomala*, sensu stricto, *U. bungeana*, *U. cordae* and *U. reticulata*. She concluded that *U. bungeana* is a synonym of *U. cordae*, two smuts which were treated by Vánky & Oberwinkler (1994:43) as two closely related species. At the same time, these authors showed that *U. anhweiana* and *U. reticulispora* are synonyms of *U. bungeana*. If *U. bungeana* is a synonym of *U. cordae*, the synonyms of *U. bungeana* are also synonyms of *U. cordae*. Meanwhile, starting with Deml & Prillinger (in Prillinger et al., 1991), continuing with Bauer & Oberwinkler (in Bauer et al, 1997), and Vánky (1998b), it was shown that this group of smut fungi belongs to the genus *Microbotryum* (*Microbotryales*). Consequently, *Ustilago anhweiana* and *U. reticulispora* are considered to be synonyms of *M. cordae* as follows:

Microbotryum cordae (Liro) G. Deml & Prillinger, in Prillinger et al., 1991:10. — Lectotype on *Polygonum hydropiper* L., Finland.

Ustilago anhweiana Zundel, 1943:167. — Type on *Polygonum* sp., China, Anhwei Prov., Chin Hua Shan, Ch'ing Yan Hsien, Ping Tou Ssu, 7.XI.1932, S.Y. Cheo 1496, BPI 157100! (syn. nov.).

Ustilago reticulispora Petrak, 1947:116 (as „*reticulisporus*"). — Type on *Polygonum bungeanum* Turcz., China, Shan-si Prov., between Taiyuan and Chinsü, at the river Fenho, 800 m., 15.X.1924, H. Smith 8023/2. (syn. nov.).

For its description, illustration and further synonyms see Vánky, 1994:355 & 399.

Ustilago enteropogonis is *U. valentula*

I described *Ustilago enteropogonis* Vánky (2002a:378), type on *Enteropogon ramosus* B.K. Simon, Australia. H. Sydow (1937:24) described *Ustilago valentula*, type on *Chloris acicularis* Lindl, Australia. When it became evident to me that *Chloris acicularis* is actually *Enteropogon acicularis* (Lindl.) Lazarides, I compared the types of these two smut fungi which showed that they are conspecific. Consequently, *Ustilago enteropogonis* is a synonym of *U. valentula* H. Sydow (syn. nov.).

Doubtful species

What is *Tilletia hyalospora* var. *cuzcoenzis*?

Hirschhorn (1943:243) described *Tilletia hyalospora* Massee var. *cuzcoenzis* Hirschh., type on *Nassella corniculata* Hack., Peru, Cuzco, Calachaca, alt. 3400 m, 26.XII.1945,

C. Vargas 5499. No material is available for study. Durán & Fischer (1961:125), within the chapter „Doubtful and excluded species“, commented that it is „probably closely allied to *T. hyalospora*“, whereas Piepenbring (2003:228), based on the rather poor description by Hirschhorn, considered var. *cuzcoenzis* to be a synonym of *Ingoldiomyces hyalosporus* (Massee) Vánky. Closer analysis of the original description and the illustration of the spores cannot confirm this view. Namely, Hirschhorn (1960:114) wrote that var. *cuzcoenzis* differs from *T. hyalospora* in the colour of the spores and „especialmente por sus reticulationes muy pequeñas y muy superficiales“ (especially by smaller and shallower reticulations). Indeed, the illustration by Hirschhorn (1960:113, Pl. III, fig. F), which is of a rather poor quality, shows two spores of var. *cuzcoenzis* which are regularly small-reticulate, far from the typical ornamentation of *I. hyalosporus*. The reticulate spore wall, with larger and deeper meshes of the smut fungus, considered by Hirschhorn to be *T. hyalospora*, is more evident in fig. 42 C (Hirschhorn, 1986:393).

Consequently, *T. hyalospora* sensu Hirschhorn, and its var. *cuzcoenzis* Hirschh. represent one, or maybe two *Tilletia* species (sp. nov.?) on *Nassella* spp., possessing reticulate spores. They are not synonyms of *I. hyalosporus*, which has peculiarly ornamented spores with coarse and fine ridges (comp. Vánky, 2002b:81, figs. B, C).

Tilletia bromi and its neotype

Tilletia bromi (Brockm.) Brockm., treated by some authors as *T. fusca* Ellis & Everh., is a species complex with numerous synonyms and host plants in various grass genera (see Durán & Fischer 1961:66 and Vánky 1994:244). Nannfeldt (in Lindeberg 1959:69), treated it in a narrow sense and recognised synonyms described only on species of *Bromus*. Its classification is far from solved. The type of *T. bromi* with all probability no longer exists (comp. also Durán & Fischer, 1961:70). Designation of a neotype is necessary, to facilitate further taxonomic work, including molecular studies.

Tilletia bromi (Brockm.) Brockmüller, Meckl. Krypt. no. 102, 1864.

Ustilago bromi Brockmüller, Arch. Vereins Freunde Naturgesch. Mecklenburg 17:233, 1863. — *Tilletia bromi* (Brockm.) Nannfeldt, in Lindeberg, 1959:69 (comb. superfl.). — Lectotype (design. by Nannfeldt, in Lindeberg, 1959:69) on *Bromus mollis* L. (= *B. hordeaceus* L.), Germany, Mecklenburg, Grabow, coll. H. Brockmüller. It was not seen by Nannfeldt, and it cannot be traced. With all probability it no longer exists. Neotype (designated here) on *Bromus mollis* L., Romania, Banat region, near Orsova, alt. c. 65 m, 15.VI.1966, leg. K. Vánky, HUV 2159. Isoneotypes in Vánky, Ust. exs. no. 105 (as *T. fusca* Ellis & Everh. on *Bromus mollis* L.).

Sori in all ovaries of an inflorescence, more or less hidden by the floral envelopes, first covered by the pale brown pericarp which ruptures irregularly disclosing the semiagglutinated to powdery, beige to pale-brown, foetid mass of spores and sterile cells. *Spores* globose, subglobose, ovoid, ellipsoidal, 20-23 x 20-25.5 μm, pale yellowish-brown, reticulate, 5-7(-8) meshes per spore diameter, muri (1-)1.5-2(-2.5) μm high, blunt, in optical median view 25-33 muri on the equatorial circumference. *Sterile cells* subglobose, ovoid, ellipsoidal to slightly irregular, 8-17 x 9-18 μm, subhyaline; wall even, 1-1.5 μm thick, smooth, content finely granular.

The smut fungi of *Tripsacinae* (*Poaceae*)

The subtribe *Tripsacinae*, within the tribe *Andropogoneae*, subfam. *Panicoideae*, contains two genera: *Tripsacum* L., with 13 closely related species, from southern USA to Paraguay, but mainly in Central America, and *Zea* L. (including *Euchlaena* Schrad.), with 4 species, in Central America, including the extensively grown *Zea mays* L. (Clayton & Renvoize, 1986:369). On *Tripsacinae* four smut fungi are recognised. These are:

1. *Sporisorium dietelianum* (Henn.) Vánky, **comb. nov.**

Basionym: *Ustilago dieteliana* Hennings, Hedwigia 37:268, 1898. — *Lundquistia dieteliana* (Henn.) Vánky, 2004c:163. — Type on *Tripsacum dactyloides* (L.) L., Mexico, near Mexico City, 1.X.1896, E.W.D. Holway; isotypes in Sydow, Ust. no. 152, HUV 3621!

Ustilago kellermanii G.P. Clinton, 1906:15. — Type on *Euchlaena luxurians* (Durieu) Durieu & Ascherson (= *E. mexicana* Schrad.), Guatemala, near Guatemala City, III.1906, W.A. Kellerman 5078, BPI 162105, BPI 162106 (syn. by Piepenbring, 2003:162).

Sori on the top of sterile shoots as long, twisted tubes or bands, 2-5 mm x 40-140 cm, partly enclosed by leaf sheaths, infecting inner leaves and the peduncle of the inflorescence. The spores develop in the parenchymatic tissues between the veins. At maturity, the host tissues rupture longitudinally and the dark brown, semiagglutinated to powdery spore mass and sterile cells are scattered leaving behind fascicles of long, filiform columellae. *Spores* globose, subglobose, broadly ellipsoidal, rarely ovoid, 8-11(-12) x 9-13 μm, yellowish-brown; wall even, c. 1 μm thick, conspicuously verrucose, spore profile wavy. *Sterile cells* in small groups, single cells variable in shape and size, from subglobose to irregular, with 1-2 flattened sides, 6-13.5 x 6-17 μm, hyaline; wall even, c. 0.5 μm thick, smooth.

On *Euchlaena mexicana* Schrad. (*E. luxurians* (Durieu) Durieu & Ascherson), *Tripsacum dactyloides* (L.) L., *T. latifolium* Hitchc., *T. laxum* Scribn. & Merr.; N. America (Mexico), C. America (El Salvador, Guatemala), West Indies (Cuba).

Presence of sterile cells between the spores was overlooked by earlier investigators.

2. *Sporisorium reilianum* (J.G. Kühn) Langdon & Fullerton, 1978:451.

Sori destroying the whole inflorescence, more rarely only the spikelets. *Spore balls* 60-100 μm long. *Spores* globose, subglobose, ovoid or slightly irregular, 10-13 x 10.5-14.5 μm, densely, minutely echinulate. *Sterile cells* in irregular groups, single cells 8-16 μm long.

For synonyms, detailed description and illustration, see Vánky, 1994:204-205 & 219.

On *Sorghum* spp. and *Zea mays* L. Cosmopolitan.

3. *Ustilago maydis* (DC.) Corda, 1842:3.

For synonyms, description and illustration, see Vánky, 1994:366 & 417.

On *Euchlaena* spp. and *Zea mays* L.; Cosmopolitan.

4. *Ustilago petrakii* Ciferri, 1931:293.

Type on *Tripsacum dactyloides* (L.) L., Santo Domingo, Puerta Plata Prov., Cordillera Septentrional, road to Santiago, hillside, 7.VII.1928, R. Ciferri; isotypes in Cif., Mycofl. doming. exs. no. 83, HUV 3028!

Sori in the inflorescence, comprising the entire inflorescence or only the spikelets, 5-12 cm long, at first agglutinated, then powdery, spore mass blackish-brown. *Spores* subglobose to ellipsoidal, more or less flattened on one side, 5.5-7 x 6.5-8 μm, in lateral view 5-6.5 μm wide, yellowish-brown, paler on one side, where the wall is thin (c. 0.4 μm), darker on the opposite side, where the wall is c. 0.8 μm thick, sparsely, minutely verrucose-echinulate which does not or just affects the spore profile.

On *Tripsacum dactyloides* (L.) L.; West Indies (Dominican Rep.).

Key to the smut fungi of *Tripsacinae*

1. Sori on the top of sterile shoots as long, twisted tubes or bands . . . . **Sporisorium dietelianum**

— Sori elsewhere 2

2. Sori on stems, leaves or inflorescence as pustules or irregular galls. Spores 7-13 μm long . . . . **Ustilago maydis**

— Sori in the spikelets or in the whole inflorescence 3

3. Spores 6.5-8 μm long, paler on one side. No sterile cells . . . . . **Ustilago petrakii**

— Spores 10.5-14.5 μm long, not paler on one side. Sterile cells present . . . . **Sporisorium reilianum**

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Ascocoma eucalypti (anamorph: *Coma circularis*), confirmation of the elusive microconidial state

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Abstract—A microconidial state was described in 1972 from the type specimen of the coelomycete *Coma circularis,* a foliar pathogen of several eucalypts including *Eucalyptus pauciflora* and of *Kunzea ericoides* (all *Myrtaceae*). Subsequently, several mycologists independently concluded that the reported microconidia probably belonged to an extraneous fungus. Discovery of the same microconidial state on freshly collected leaves of *E. pauciflora* and two early specimens of another eucalypt (probably *E. cypellocarpa*) confirms the original report.

Key words—leaf spot, spermatia, spermogonia

Introduction

Few collections have been made of the foliar pathogen *Coma circularis* (Cooke & Massee) Nag Raj & W.B. Kendr. or its associated teleomorphs, *Ascocoma eucalypti* H.J. Swart and *Ascocoma eucalypti* var. *didymospora* H.J. Swart. The first collection of the anamorph, evidently from *Eucalyptus pauciflora* (Swart 1986), was made by Mrs F. Martin in the Victorian Alps and described in 1890 as *Pestalozziella circulare* Cooke & Massee (Cooke 1890). Hansford (1956) later described a September 1924 collection by G. Samuel from an unidentified mallee-type eucalypt from Pinnaroo in South Australia. The leaves bore fruiting bodies that had produced both an anamorph and its apparent teleomorph, to which Hansford applied the names *Gloeosporiella eucalypti* and *Pseudopeziza eucalypti*, respectively. The anamorph has since been reported from New Zealand on *Kunzea ericoides*, the first recorded occurrence on a species other than a eucalypt (Gadgil & Dick 1999).

The holotype of *Pestalozziella circulare* and two additional collections made at the same time by Mrs Martin were re-examined by Nag Raj and Kendrick (1972), who excluded the fungus from *Pestalozziella* and erected the genus *Coma* to accommodate it. In addition, they described a microconidial state on the type specimen comprising 'oval to cylindrical hyaline microconidia borne on subulate conidiogenous cells in black, sub-cuticular or intraepidermal, nonostiolate, lenticular pycnidia'. They considered the microconidial state to be that of *C. circularis*.

Sutton (1974) recognised the fungus described by Hansford as *Gloeosporiella eucalypti* to be a previously unrecognised collection of *Coma circularis*. Sutton found no microconidia in either this specimen or the holotype, and expressed reservations concerning the description by Nag Raj and Kendrick (1972) of a microconidial state. Sutton interpreted their illustration of a branched microconidiophore as that of an immature appendaged conidium producing a microconidium at its apex, 'an unlikely type of ontogeny' (Sutton 1974).

Swart (1986) resolved the identity of the teleomorph of *C. circularis,* for which more than one candidate had been proposed (Hansford 1956, Nag Raj 1979). A 1985 collection of juvenile leaves of *Eucalyptus pauciflora* from the Victorian Alps bore a teleomorph in unambiguously close association with conidiomata of *Coma circularis*. Swart proposed the new genus *Ascocoma* to accommodate both the newly collected teleomorph and Hansford's specimen, which had been incorrectly placed in *Pseudopeziza* (Swart 1986). Thus, *Pseudopeziza eucalypti* Hansf., which had single-celled ascospores, became *Ascocoma eucalypti* (Hansf.) H.J.Swart, while the teleomorph from the new collection, which had two-celled ascospores, was designated *A. eucalypti* var. *didymospora* H.J.Swart. Swart pointed out that the difference in spore septation may have simply reflected different levels of maturity, although he also recognised the possibility of geographical variation. Swart (1986), like Sutton (1974), failed to find any evidence of a microconidial state in the collections he examined, and similarly concluded that the microconidia described by Nag Raj and Kendrick (1972) were probably those of a fungus other than *Coma circularis*. After kindly viewing the specimen described here, however, Swart realised that he had probably seen poorly preserved microconidial conidiomata when he had examined the type material of *Pestalozziella circularis* at Herb. K some years previously. Two more VPRI specimens have now come to our notice. They are of *Coma circularis* (as *Pestalozziella circulare*) on leaves identified as being most likely from *Eucalyptus cypellocarpa,* and certainly not from *E. corynocalyx* (now known as *E. cladocalyx*) as indicated on the packet. The specimens, collected in 1914 by C. French Jnr on Mt Baw Baw in Victoria, showed prolific development of both microconidial conidiomata and normal conidiomata. Curiously, one of these specimens (VPRI 2309) bore the annotation 'New for Victoria, 26/1/14' despite the fact that Mrs Martin's earlier collections were also from Victoria.

Observations and Discussion

The first author collected juvenile leaves of *E. pauciflora* infected with *A. eucalypti* numerous times in recent years from the Mt Howitt region in the Victorian Alps. The collections have, with one exception, been made at Easter, and consequently the dates of collection have varied over the months of March and April. In the first collection, on April 7 1985, only immature conidia were found. However, a second sample collected several weeks later yielded an abundance of both the conidial and ascal states, and became the holotype of *Ascocoma eucalypti* var. *didymospora* (Swart 1986). On March 31 1991, the first author gathered two heavily infected juvenile leaves from a 50 cm seedling of *E. pauciflora*. Each of five fructifications examined proved to be microconidial and consistent with those described by Nag Raj and Kendrick (1972).

1

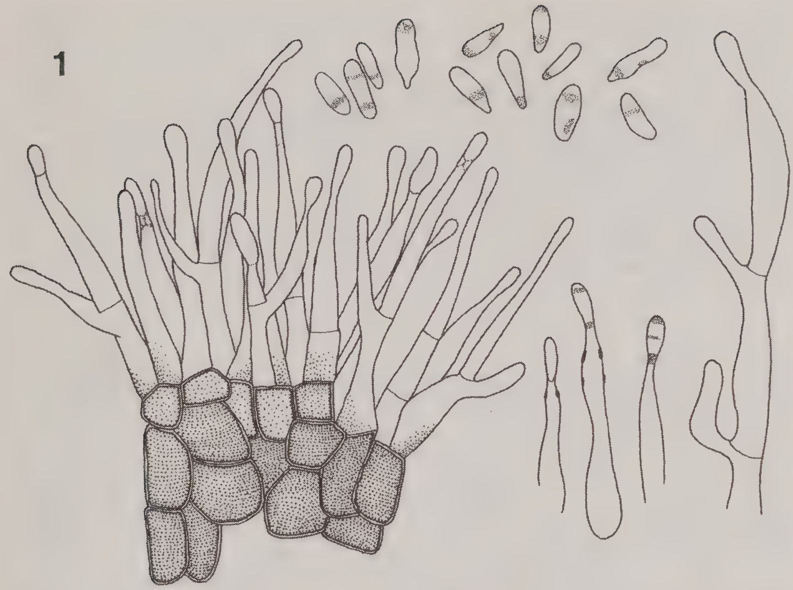

Fig. 1: VPRI 17238. Microconidiophores, some branched or showing irregular rough pigmentation, and microconidia. Bar = 10 μm

In sections made through several of these fructifications, immature ascomatal layers were readily seen developing below mature microconidial conidiomata. It is likely that the microconidia described for *A. circularis* (and many other ascomycetes) function as spermatia, in which case ascoma development would depend on the prior development of the microconidial state. The first stage in the development of conidiomata and ascomata in *A. eucalypti* is the formation of a pseudoparenchymatous stroma beneath the cuticle (Swart 1986). Swart mentioned that asci and paraphyses arise in the lower layers of the stroma, the upper layers of which lift and break away. It is evident that the microconidial conidiomata of *A. circularis* develop in the upper part of the stroma and slough off with it, which explains why they are not found in association with mature ascomata. If the microconidia of *C. circularis* are indeed functional spermatia, the situation differs from that seen in many ascomycetes in which the microconidial conidiomata are spatially separated from the ascomata and persist after ascoma formation.

The immature microconidial conidioma shown in Fig. 2 underlies the heavily melanised fungal layer which lines the leaf cuticle. The hymenium of slender, occasionally branched and irregularly pigmented microconidiophores (Figs 1, 4 and 5) was generated by the uppermost pigmented band of stroma cells (Figs 2, 3). The lightly pigmented zone beneath this dark stroma was a developing ascogenous hymenium generated by a second dark stromatic layer situated deeper in the leaf tissue. The microconidiophores (Figs 1, 4 and 5) were enteroblastic (probably phialidic), 0–2 septate, often branched near the base and again 0–2 times higher up (Fig. 1). They were 17–25 (–40) µm long, ca 4 µm wide at the base and 1.5 µm wide at the tip, hyaline or pale olivaceous brown towards the base and hyaline towards the apex. The brown pigmentation of the stroma cells extended unevenly for 4–5 µm up the walls of some microconidiophores (Fig. 1). Many microconidiophores in one cluster displayed slightly roughened wall thickening near the apex, and the constricted neck region was often darkly pigmented (Figs 1, 5). Whether the pigment in this region was within the periclinal thickening, in the outer wall layer of the conidiogenous cell apex or in an external deposit, is not certain, although the latter appears most likely. The microconidia were predominantly hyaline but they, too, commonly had one or two pale brown wall patches which lent them a pale brownish appearance in mass (Figs 1, 4). They were 3.5–6 µm long x 1–2 µm wide (n =12), dimensions in close agreement with those given by Nag Raj and Kendrick (1972).

The fungus on *E. cypellocarpa* differed from that on *E. pauciflora* in that the microconidiophores and microconidia were hyaline. The microconidial loculi were planate and often confluent, as were the ascomatal and conidiomatal loculi illustrated by Swart (1986). They were as much as 450 µm in diameter and were interspersed with conidiomata beneath the continuous, heavily melanised sub-cuticular fungal layer which is typical of the species. Similar broad microconidiomata were seen in VPRI 17238, although those shown in Figs 2 and 3 were narrower in that plane of section.

> **SPECIMENS EXAMINED: AUSTRALIA. VICTORIA:** Near Mt Howitt, Stanleys Name Spur, on juvenile leaves of *Eucalyptus pauciflora* Sieber ex Spreng., V. Beilharz, 31 March 1991, *VPRI 17238*; MT BAW BAW, on juvenile leaves of *E. ?cypellocarpa.*, C. French Jnr, 26 Jan. 1914, *VPRI 2308*; *ibid.*, *VPRI 2309.*

Spermatial states of ascomycetes are most often quickly formed and short-lived, so luck plays a part in their successful collection. Sutton's misinterpretation of the branched microconidiophores illustrated by Nag Raj and Kendrick (1972) is understandable, even though the scale bar correctly showed them to be very much smaller than the conidia with which Sutton confused them. The collection dates for the Mt Howitt specimens of *E pauciflora*, all collected at high altitudes, shed some light on the pattern of disease development of the pathogen on that host in that locality, although annual climatic variations can also be expected to have an influence. Specimens with microconidia were collected on March 31 (1990), immature conidia on April 7 (1985), mature conidia and immature asci on April 12 (1993), and mature conidia and asci containing mature ascospores on May 5 (1985). The Mt Baw Baw collections (January 1914) came from a host which grows only at lower altitudes than *E. pauciflora*, with no overlap in ranges, and Samuel's collection (September 1924) came from semi-arid low-lying scrubland.

Figs 2–5: Microconidial state of *Coma circularis* (VPRI 17238).

Fig. 2: Vertical section of immature microconidioma (m) subtended by a dark stromatic layer and, below that, a pale stroma which is a very immature, developing ascoma (a).

Fig. 3: Vertical section of a microconidioma (m) exposed by rupture of the overlying tissues and subtended by a developing ascoma (a).

Fig. 4: Groups of microconidiophores borne on pigmented stroma cells.

Fig. 5: Several microconidiophores showing dark, rough pigmented areas towards the apices, and irregular pigmentation of an attached microconidium (arrowed).

Bars = 50 μm (Figs 2, 3), 20 μm (Fig. 4), 10 μm (Fig. 5).

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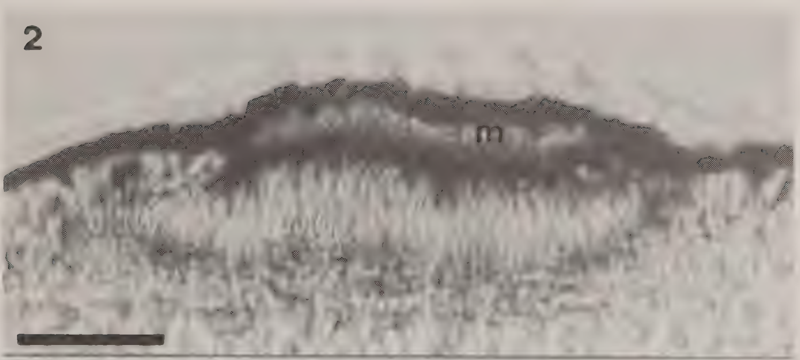

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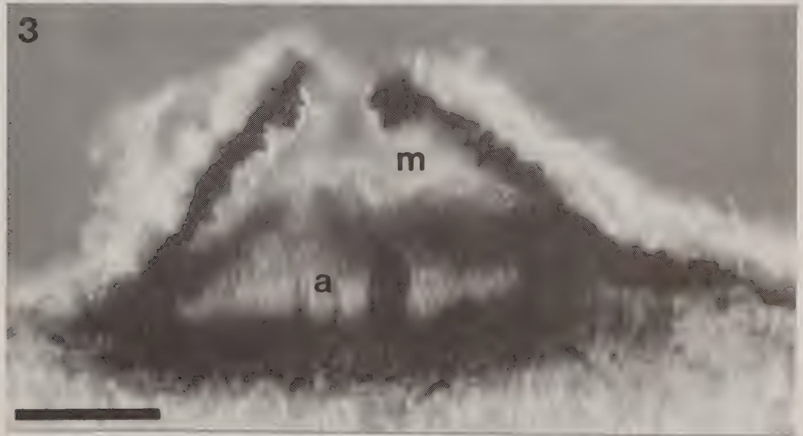

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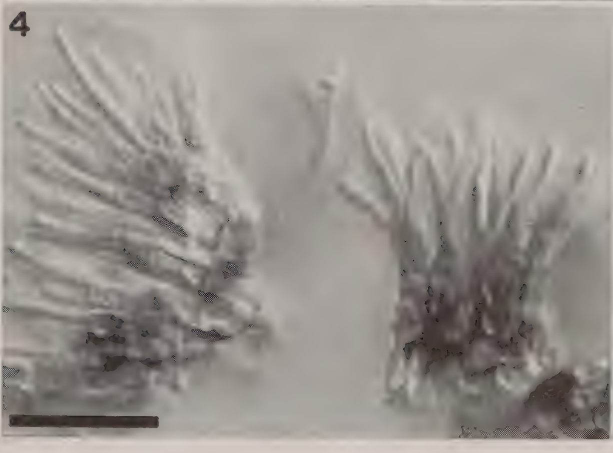

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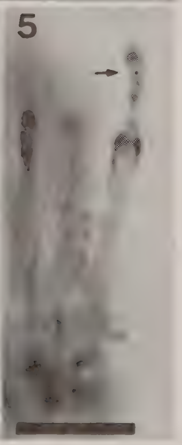

Acknowledgments

We acknowledge with gratitude the interest and helpful comments of the late Harry Swart, who confirmed the identity of the microconidiomata on the *E. pauciflora* specimen. Pauline Ladiges kindly identified the eucalypt host in the Baw Baw collections and Doug Parbery and Philip Keane are thanked for critically reading the manuscript.

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Additional new taxa in the lichen genus *Pertusaria* (Lichenized Ascomycota) from Thailand

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Abstract—*Pertusaria alboaspera* var. *tetraspora, P. archeri, P. bokluensis, P. elixii, P. hypostictica, P. inthanonensis, P. kansriae, P. krabiensis, P. loeiensis, P. siamensis, P. thailandica* and *P. uttaraditensis* from Thailand are reported as new to science.

Introduction

An investigation of Thai *Pertusaria* specimens from RAMK (Lichen Research Unit, Ramkhamhaeng University, Bangkok), CMU (Chiang Mai University), PSU (Department of Chemistry, Prince of Songkhla University) and the herbarium of S. Jariangprasert (SJ), showed the presence of several new taxa (Jariangprasert et al. 2002, 2003, 2004). Subsequent examination of additional specimens has disclosed the presence of a further twelve taxa which are described here.

The new taxa are distinguished from known species on the basis of the number of ascospores per ascus, the apothecial and ascospore morphology, and chemistry. In view of the large number of *Pertusaria* species already published, morphological features are no longer sufficient to distinguish taxa and chemistry is playing an increasingly important role in the differentiation of taxa. The situation is similar to that in the genus *Siphula*, where apothecia and ascospores are unknown, and chemistry is essential to separate taxa (Kantvilas 1998).

The chemistry of new species was determined by thin layer chromatography (Elix & Ernst-Russell 1993) and confirmed by high performance liquid chromatography (Elix et al. 2003). Ascospore morphology nomenclature follows Dibben (1980). The locations of the 76 Provinces in Thailand are shown in Wolsely et al. (2002, Fig.1). A key to all of the species will be published later. All SJ specimens will be deposited in QBG (The Queen Sirikit Botanic Garden at Mae Rim District, Chiang Mai Province 50180 Thailand).

Taxonomic Descriptions

Pertusaria alboaspera A.W. Archer & Elix
var. ***tetraspora*** Jariangprasert *var. nov.* **Figure 1**

Similis *Pertusaria alboaspera* A.W. Archer & Elix sed ascis tetrasporis differt.

Etymology: from the Latin *tetra*, four, a reference to the four-spored asci.

Type: **THAILAND. Loei Province**: Phu Luang Wildlife Sanctuary, close to Pha Chang Phan Cliff, alt. 1510 m, on unidentified fragrant tree trunk next to the cliff, in oak/dipterocarp forest, *S. Jariangprasert 2248*, 3.ii.2002; holotype: QBG.

KEY CHARACTERS—Thallus corticolous, off-white to ivory-grey, surface smooth to subtuberculate, cracked, lacking isidia and soredia. **Apothecia** verruciform, conspicuous, flattened hemispherical, numerous, scattered, constricted at the base, rarely confluent, 0.6–1.5 mm diam. **Ostioles** hyaline, inconspicuous, 14 per verruca. **Ascospores** (3–)4 per ascus, uniseriate, subfusiform to ellipsoid, 72–92 μm long, 32–45 μm wide, smooth, inner wall trimmed, outer wall 5–7.5 μm thick.

Chemistry—K+ yellow, KC-, C-, Pd+ orange, UV+ bright yellow; lichexanthone (minor), 2,2'-di-*O*-methystenosporic acid (major), planaic acid (trace), methyl 2,2'-di-*O*-methystenosporate (trace), stictic acid (minor) and constictic acid (minor).

Ecology—*Pertusaria alboaspera* var. *tetraspora* is a corticolous species found in the northern and northeastern regions of Thailand at 1100–1900 m on *Acronychia, Betula, Persea, Prunus, Rhododendron* and *Wrightia* and other unidentified trees.

COMMENTS—*Pertusaria alboaspera* var. *tetraspora* is characterised by the many small apothecia with flattened tops (as if rubbed down), asci with four smooth ascospores and the presence of lichexanthone, 2,2'-di-*O*-methystenosporic and stictic acids. The species is chemically identical to *P. alboaspera* (Archer & Elix 1993) but that species has eight ascospores per ascus.

REPRESENTATIVE SPECIMENS EXAMINED—THAILAND. Chiang Mai Province: Chiang Dao District, Huai Nam Dang National Park, by side of road to the new palace, in hill evergreen forest with pine, *S. Jariangprasert 4683.2*, 25.xii.2002 (QBG); behind welfare shop, on slope close to road to Ban Lee So, on plant debris, *S. Jariangprasert 4780.2*, 25.xii.2002 (QBG); Jom Thong District, Doi Inthanon National Park, gateway to Mae Raed Headwaters, on bark of Fagaceae, in hill evergreen forest, *S. Jariangprasert 2398*, 13.iii.2002 (QBG); *ibid.*, opposite the 40 km stone, in hill evergreen forest, *S. Jariangprasert 2489*, 13.iii.2002 (QBG).

Nan Province: Pua District, Doi Phuka National Park, right hand side of road to mountain summit, between 36 and 35 km stones, in hill evergreen forest, *S. Jariangprasert 1585,* 9.vi.2001 (QBG).

Phitsanulok Province: Nakhon Thai District, Phu Hin Rongkla National Park, right hand side of road from Mhun Daeng Waterfall, at 37 km stone, in hill evergreen forest, *S. Jariangprasert 2065.1, 2066.2, 2068, 2072.2, 2078,* 19.i.2002 (QBG); *ibid.*, slope opposite track to Tap Boeg view point shelter, in pine forest, *S. Jariangprasert 2085, 2088.1, 2089, 2090, 2097*, 19.i.2002 (QBG); *ibid.*, Tap Boeg view point shelter, on base of western column, *S. Jariangprasert 2101.1,* 19.i.2002 (QBG).

Loei Province: Phu Luang Wildlife Sanctuary, left hand side of Song Phra Jaroen placard, in oak/dipterocarp forest, *S. Jariangprasert 2288*, 3.ii.2002 (QBG); *ibid.*, grass land on left hand side of trail to Ban Kaifa Phayalo guest house, in oak/dipterocarp forest, *S. Jariangprasert 2205*, 3.ii.2002 (QBG); *ibid.*, in front of the old palace, in oak/dipterocarp forest, *S. Jariangprasert 2163, 2164*, 3.ii.2002 (QBG); *ibid.*, on unidentified tree trunk, *S. Jariangprasert 2254-2258*, 3.ii.2002 (QBG); *ibid.*, in front of the Channel 7 station, in oak/dipterocarp forest, *S. Jariangprasert 2261*, 3.ii.2002 (QBG); *ibid.*, before Pha Chang Phan Cliff, on bark of Malvaceae, in oak/dipterocarp forest, *S. Jariangprasert 2282*, 3.ii.2002 (QBG); *ibid.*, between Pha Chang Phan Cliff and Pha Somdej Cliff, in scrub forest, *S. Jariangprasert 2268*, 3.ii.2002 (QBG).

Pertusaria archeri Jariangprasert *sp. nov.* **Figure 2**

Similis *Pertusaria novaeguineae* A.W. Archer & Elix sed acidum sticticum deficiens.

Etymology: the epithet "archeri" refers to Dr. A.W. Archer (NSW), who has contributed to our knowledge of *Pertusaria* taxonomy.

Type: **THAILAND. Lamphun-Lampang Provinces**: Doi Khun Tan National Park, before Yo 2, alt. 1010 m, on bark of *Styrax*, in hill evergreen forest, *S. Jariangprasert 2359*, 8.iii.2002; holotype: QBG.

KEY CHARACTERS—Thallus corticolous, olive green, surface shiny, smooth and slightly wrinkled, isidia and soredia absent. **Apothecia** verruciform, conspicuous, concolourous with the thallus, flattened to concave hemispherical, constricted at the base, not confluent, sometimes with fissures from the ostioles to the base of the apothecia, 0.5–1.2 mm diam. **Ostioles** black, conspicuous, dented and rarely fused, 1–3(–5) per apothecia. **Ascospores** 2 per ascus, elongate–ellipsoid, 140–174 μm long, 36–46 μm wide, smooth; inner wall trimmed, outer wall 8–12 μm thick.

Chemistry—K-, KC-, C-, Pd-, UV-; methyl 2'-*O*-methylstenosporic acid (major), planaic acid (minor), 2'-*O*-methylperlatolic acid (minor), methyl 2-*O*-methylperlatolate (minor) and methyl planaiate (minor).

Ecology—*Pertusaria archeri* is a rare endemic corticolous species known only from the type specimen from Khun Tan National Park, Lamphun-Lampang Provinces at 1010 m in northern Thailand.

COMMENTS—*Pertusaria archeri* is characterised by two smooth ascospores and the presence of depside methyl esters. Compounds of this type are uncommon in the genus *Pertusaria* but methyl 2-*O*-methyldivaricatate has recently been reported in *P. litchicola* (Jariangprasert & Archer 2003). The new species resembles *P. novaeguineae* (Archer & Elix 1998) but is distinguished from that species by the absence of stictic acid and the presence of depside methyl esters.

Pertusaria bokluensis Jariangprasert *sp. nov.* **Figure 3**

Sicut *Pertusaria subplanaica* A.W. Archer & Elix sed ascosporis minoribus et ostiolis albidis differt.

Etymology: from the Latin *ensis*, place of origin, and Bokluea District.

Type: **THAILAND. Nan Province**: Bokluea District, Bo Kluea Nhuea Community, by side of path from Bo Kluea Nhuea to Bo Kluea District, before the 14 km stone, alt. 1000 m, on bark of *Dalbergia*, *S. Jariangprasert 1616*, 9.vi.2001; holotype: QBG.

KEY CHARACTERS—**Thallus** corticolous, glaucous green, surface smooth, with medullary crystals, isidia and soredia absent. **Apothecia** verruciform, conspicuous, scattered, usually concolourous with the thallus but paler above, constricted at the base, rarely confluent, 1–2 per verruca, 0.5–0.9 mm diam. **Ostioles** hyaline, inconspicuous, 1–3 per apothecia, 1–4 per verruca. **Ascospores** 6–8 per ascus, irregularly uniseriate to basally biseriate, ellipsoid, 60–78(–86) μm long, 28–40 μm wide, smooth; inner wall trimmed, outer wall 6–8 μm thick.

Chemistry—K-, KC-, C-, Pd-, UV+ red orange; 4,5-dichlorolichexanthone (minor) and 2,2'-di-*O*-methylstenosporic acid (major).

Ecology—*Pertusaria bokluensis* is a rare endemic corticolous species known only from the type specimen from Bokluea District, Nan Province, at an altitude of 1000 m, in northern Thailand.

COMMENTS—*Pertusaria bokluensis* is characterised by asci with eight ascospores and the presence of 4,5-dichlorolichexanthone and 2,2'-di-*O*-methylstenosporic acid. The new species is chemically similar to *P. subplanaica* but has smaller, biseriate ascospores, 60–78 x 28–40 μm, compared to the uniseriate ascospores, 78–112 x 34–40 μm, in *P. subplanaica* (A.W. Archer & Elix 1992).

Pertusaria elixii Jariangprasert *sp. nov.* **Figure 4**

> Similis *Pertusaria alboaspera* A.W. Archer & Elix sed ascis tetrasporis et acida 2'-*O*-methylstenosporicum, 2'-*O*-methyldivaricaticum et 2'-*O*-methylperlatolicum continens.
>
> *Etymology*: the epithet "elixii" refers to Professor Dr. J. A. Elix (ANU), who has assisted in the chemical analysis of our *Pertusaria* specimens.

Type: **THAILAND. Chiang Mai Province**: Jom Thong District, Doi Inthanon National Park, opposite the 40 km stone, alt. 1900 m, on *Betula alnoides* Buch.-Ham. ex G. Don, in hill evergreen forest, *S. Jariangprasert 2405*, 13.iii.2002; holotype: QBG.

KEY CHARACTERS—**Thallus** corticolous, pale yellowish-green, surface smooth and cracked, shiny, isidia and soredia absent. **Apothecia** verruciform, conspicuous, paler above, rarely confluent, arranged longitudinally along the tree trunk, 0.6–1.4 mm diam. **Ostioles** inconspicuous, sunken, 1–4 per verruca. **Ascospores** 4 per ascus, uniseriate, subfusiform to ellipsoid, 90–110 μm long, 34–50 μm wide, smooth, outer wall 6–10 μm thick.

Chemistry—K+ pale yellow, KC-, C-, Pd+ orange, UV+ pale orange-yellow; lichexanthone (minor), 2'-*O*-methylstenosporic acid (major), 2'-*O*-methyldivaricatic acid (minor), 2'-*O*-methylperlatolic acid (minor), stictic acid (minor), and constictic acid (minor).

Ecology—*Pertusaria elixii* is a rare endemic corticolous species known only from the type specimen from Inthanon National Park, Chiang Mai Province, at an altitude of 1900 m in northern Thailand.

COMMENT—*Pertusaria elixii* is characterised by asci with four smooth ascospores and the presence of 2'-*O*-methyl-substituted homologues of perlatolic acid. The new species is distinguished from *P. alboaspera* by the number of ascospores and the chemistry; that species has eight ascospores and contains 2,2'-di-*O*-methystenosporic acid (A.W. Archer & Elix 1993).

Pertusaria hypostictica Jariangprasert *sp. nov.* **Figure 5**

Similis *Pertusaria muricata* J.C. David sed acidum hyposticticum continens differt.

Etymology: the name of the new taxon refers to the presence of hypostictic acid.

Type: **THAILAND. Nakhon Ratchasima Province**: Khao Yai National Park, along roadside to Pha Trom Jai Cliff, before a military post, alt. 1233 m, on bark of Fagaceae, in dry evergreen forest, *S. Jariangprasert 1379,* 17.xii.2000; holotype: QBG.

KEY CHARACTERS—**Thallus** corticolous, olive green to green, surface smooth, glossy, isidiate; soredia absent. **Isidia** hollow, initially globular, becoming cylindrical coralloid, easily broken and becoming pseudo-servediate, 0.3 mm diam., 0.5–0.7 mm long. **Apothecia** unknown.

Chemistry—**K+** yellow, KC-, C-, Pd+ orange, UV-; stictic acid (major), hypostictic acid (minor), cryptostictic acid (minor), peristictic acid (minor), substictic acid (minor) and constictic acid (trace).

Ecology—*Pertusaria hypostictica* is a corticolous, isidiate species found predominantly at ca. 1200 m in Khao Yai National Park, Nakhon Ratchasima Province, in the eastern region of Thailand, and also at 120 m in the Peninsular region in southern Thailand. Reported substrates include *Mangifera* and *Schima.*

COMMENTS—*Pertusaria hypostictica* is characterised by the isidiate thallus and the presence of stictic and hypostictic acids. The new species resembles *P. muricata* David (David & Hawksworth 1995) both morphologically and chemically, but is distinguished from that species by the presence of additional hypostictic acid which is absent from *P. muricata.*

REPRESENTATIVE SPECIMENS EXAMINED—THAILAND. Nakhon Ratchasima Province: Khao Yai National Park, along roadside to Pha Trom Jai Cliff, before a military post, alt. on bark of Fagaceae, in hill evergreen forest, *S. Jariangprasert 1351, 1381, 1389, 1390,* 17.xii.2000 (QBG); *ibid.,* right hand side behind the military post, *S. Jariangprasert 4866,* 16.viii.2003 (QBG); *ibid.,* behind a shop behind the military post, *S. Jariangprasert 4871,* 16.viii.2003 (QBG); *ibid.,* Khao Khiao, right hand side of trail from Pha Diao Dai Cliff, in hill evergreen forest, *S. Jariangprasert 1474, 1475, 1477, 1502,* 17.xii.2000 (QBG).

Nakhon Si Thammarat Province: Tung Song District, Nam Tok Yong National Park, *S. Jariangprasert 2904, 2905,* 9.x.2002 (QBG).

Pertusaria inthanonensis Jariangprasert *sp. nov* **Figure 6**

Similis *Pertusaria gracilis* var. *heteromera* Müll. Arg. sed ascis tetraspora differt.

Etymology: from the Latin *ensis*, place of origin, and Doi Inthanon National Park.

Type: **THAILAND. Chiang Mai Province**: Jom Thong District, Doi Inthanon National Park, opposite 40 km stone, alt. 1900 m, on bark of *Betula alnoides* Buch.-Ham. ex G. Don, in hill evergreen forest, *S. Jariangprasert 2492*, 13.iii.2002; holotype: QBG; *S. Jariangprasert 2404*, topotype: RAMK.

KEY CHARACTERS—Thallus corticolous, off-white to ivory, zonated margin, isidia and soredia absent. **Apothecia** verruciform, hemispherical, constricted at base, rarely confluent, 1–4 per verruca, 0.4–0.6 mm diam. **Ostioles** black, punctiform, conspicuous, some fused, 1–4 per apothecia, 1–7 per verruca. **Ascospores** (1–)2–4 per ascus, ellipsoid-cylindrical, rarely reniform and subfusiform, 80–176(–206) μm long, 34–54 μm wide, smooth, inner wall trimmed and laminated, outer wall (4–)10–16 μm thick.

Chemistry—K+ bright yellow, KC-, C-, Pd+ apricot orange, UV+ bright yellow; lichexanthone (major-minor), confluentic acid (major), hyperconfluentic acid (minor), stictic acid (major), constictic acid (minor), 2'-*O*-methylmicrophyllinic acid (minor-trace), ±skyrin (minor) and ±graciliformin (minor).

Ecology—*Pertusaria inthanonensis* occurs at 700–1600 m in the northern and north-eastern regions of Thailand. Reported substrates include *Harrisonia, Lithocarpus* and *Quercus.*

COMMENTS—*Pertusaria inthanonensis* is characterised by asci with two-four smooth ascospores and the presence of lichexanthone, confluentic and stictic acids. The new species is chemically similar to *P. gracilis* var. *heteromera* (Müller 1884) but this species has eight smaller ascospores per ascus.

REPRESENTATIVE SPECIMENS EXAMINED—THAILAND. Chiang Rai Province: Phan District, Tambon Pa Hung, Doi Lhuang National Park, behind Doi Mhok, Pang Pa Gluay and Pang Pa Ma Kham Pom, on Fagaceae, in hill evergreen forest, *S. Jariangprasert 3571*, 14.xi.2002 (QBG); *ibid.*, Ban Pang Pu Lo, on Fagaceae, in hill evergreen forest, *S. Jariangprasert 3463.1, 3484, 3487,*13.xi.2002 (QBG).

Chiang Mai Province: Mueang District, Doi Suthep-Pui National Park, track to defense fire line, top of Doi-Pui, on fallen log, in hill evergreen forest, *S. Jariangprasert 1563,* 1.vi.2001 (QBG), between 13-14 km, on trail to Doi Pui parking area, on Fagaceae, in hill evergreen forest, *S. Jariangprasert 2376*, 17.ix.2002 (QBG); Mae Rim District, The Queen Sirikit Botanic Garden, by side of slope, opposite the Garden, in deciduous forest, *K. Boonpragob s.n.*, 28.vi.1994, RU 2504 (RAMK); Jom Thong District, Doi Inthanon National Park, at 27 km stone, in mixed deciduous/pine forest, *S. Jariangprasert 2426, 2467,* 13.iii.2002 (QBG).

Loei Province: Phu Luang Wildlife Sanctuary, in front of the old palace, in oak/dipterocarp forest, *S. Jariangprasert 2162*, 3.ii.2002 (QBG); *ibid.*, by side of trail to Channel 7 station, in oak/dipterocarp forest, *S. Jariangprasert 2178*, 3.ii.2002 (QBG); *ibid.*, between Pha Chang Phan Cliff and Pha Somdej Cliff, in scrub forest, *S. Jariangprasert 2220*, 3.ii.2002 (QBG).

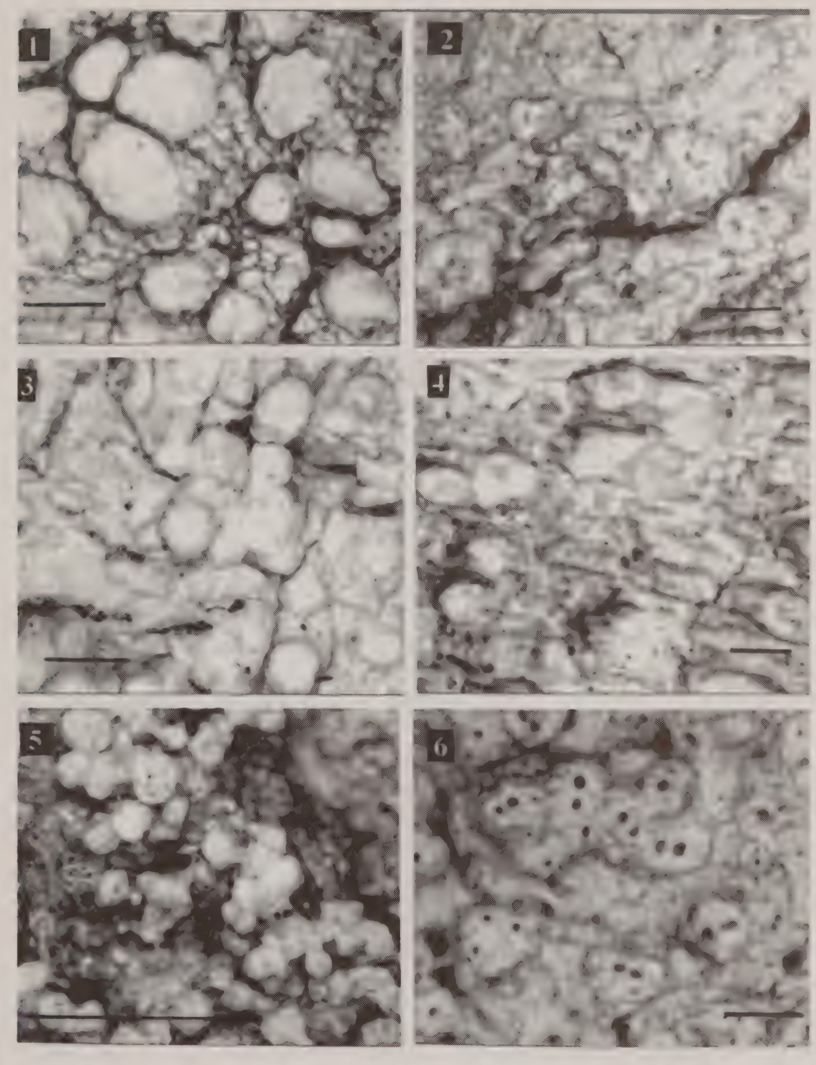
Pertusaria kansriae Jariangprasert *sp. nov* **Figure 7**

Sicut *Pertusaria subplanaica* var. *tetraspora* Jariangprasert & A.W. Archer sed acidum 2,2'-di-*O*-methylstenosporicum deficiens.

Etymology: the epithet "kansriae" refers to Dr. Kansri Boonpragob (RAMK) who inspired me (SJ) to study lichens and in gratitude for her friendship over the years.

Type: **THAILAND. Chiang Mai Province**: Doi Inthanon National Park, right hand side of bridge No. 5, gateway to Ban Pha Mhon, alt. 980 m, on tree trunk, in mixed pine and Fagaceae forest, *S. Jariangprasert 2473.2*, 13.iii.2002; holotype: QBG.

KEY CHARACTERS—**Thallus** corticolous, whitish-green, surface slightly wrinkled and areolate, dull, isidia and soredia absent. **Apothecia** verruciform, conspicuous, flattened hemispherical, concolourous with the thallus, irregular in outline, rarely confluent, not constricted at the base, 2–3 per verruca, 0.4–0.8 mm diam. **Ostioles** translucent, inconspicuous, even or slightly depressed, 1–2 per apothecia. **Ascospores**



Figures 1-6. New taxa of *Pertusaria*. **1.** *P. alboaspera* var. *tetraspora,* S. Jariangprasert 2254 (QBG); **2.** *P. archeri*, holotype (QBG); **3.** *P. bokluensis,* holotype (QBG); **4.** *P. elixii*, holotype (QBG); **5.** *P. hypostictica,* S. Jariangprasert 4871 (QBG); **6.** *P. inthanonensis,* holotype (QBG). Scale bar = 1.0 mm.

4 per ascus, uniseriate, ellipsoid, 80–110 μm long, 32–42 μm wide, smooth, outer wall 6–8 μm thick.

Chemistry—K-, KC-, C-, Pd-, UV+ orange; 4,5-dichlorolichexanthone (minor), 2'-*O*-methylstenosporic acid (major) and 2'-*O*-methyldivaricatic acid (trace).

Ecology—*Pertusaria kansriae* is a rare, endemic corticolous species known only from the type specimen from Doi Inthanon National Park, Chiang Mai Province, in the northern region of Thailand.

COMMENTS—*Pertusaria kansriae* is characterised by asci with four ascospores and the presence of 4,5-dichlorolichexanthone and 2'-*O*-methylstenosporic acid. The new species is morphologically similar to *P. subplanaica* var. *tetraspora* but in that species 2,2'-di-*O*-methylstenosporic acid is the major compound (Jariangprasert et al. 2003). It is chemically similar to *P. praetermissa* but that species has eight smaller ascospores (Archer 1997).

Pertusaria krabiensis Jariangprasert *sp. nov.* **Figure 8**

Similis *Pertusaria follmanniana* A.W. Archer & Elix sed ascis octosporis et 2-chlorolichexanthone deficiens differt.

Etymology: from the Latin *ensis*, place of origin, and Krabi Province.

Type: **THAILAND. Krabi Province**: around Wat Thamp Suea Temple, *F. David & J.A. Elix* 108, 27.vii.1990; holotype: PSU.

KEY CHARACTERS—**Thallus** corticolous, olive green with scattered tiny white dots, surface areolate and cracked, isidia and soredia absent. **Apothecia** verruciform, conspicuous, hemispherical, constricted at base, rarely confluent, sometimes fissured from the ostioles to the base of the verrucae, 0.5–0.9 mm diam. **Ostioles** black, conspicuous, slightly raised, 1–3 per apothecia. **Ascospores** 8 per ascus, uniseriate, ellipsoid, 60–100(–120) μm long, 26–46(–60) μm wide, smooth; inner wall trimmed, outer wall 6–12 μm thick.

Chemistry—K+ yellow, KC-, C-, Pd+ orange, UV-; 2-*O*-methylsuperlatolic acid (major), 2-*O*-methylhyperlatolic acid (minor), 2-*O*-methylisohyperlatolic acid (minor), superplanaic acid (minor), hyperplanaic acid (trace), isohyperplanaic acid (minor), stictic acid (major), peristictic acid (minor) and cryptostictic acid (minor).

Ecology—*Pertusaria krabiensis* is a rare, endemic corticolous species known only from the type specimen from Krabi Province in peninsular Thailand.

COMMENTS—*Pertusaria krabiensis* is characterised by asci with eight uniseriate ascospores and the presence of higher homologues of 2-*O*-methylperlatolic acid. It is similar morphologically and chemically to *P. follmanniana* (Elix et al. 1995b) but *P. krabiensis* has four ascospores and lacks 2-chlorolichexanthone.

Pertusaria loeiensis Jariangprasert *sp. nov.* **Figure 9**

Sicut *Pertusaria tapadensis* Elix & A.W. Archer sed ostiolis et ascosporis minoribus.

Etymology: from the Latin *ensis*, place of origin, and Loei Province.

Type: **THAILAND. Loei Province**: Nahaeo National Park, by side of Hueang River, alt. 540 m, on bark of *Neolithea* in dry evergreen forest, *P. Mongkonsuk*, 15.vii.1995; holotype RU 6311 (RAMK); topotype RU 6315 (RAMK).

KEY CHARACTERS—**Thallus** corticolous, dark olive green, surface smooth to slightly wrinkled with small, short ridges, cracked, isidia and soredia absent. **Apothecia** verruciform, conspicuous, confluent, sometimes irregular in outline, rarely single, constricted at base, 0.7–2.2 mm diam. **Ostioles** black, even, conspicuous, many per verruca, rarely fused. **Ascospores** 2, rarely 3 or 4, per ascus, ellipsoid, 84–130 μm long, 28–48 μm wide, smooth; outer wall 6–11 μm thick.

Chemistry—K+ yellow, KC-, C-, Pd+ orange, UV-; 4,5-dichlorolichexanthone (trace), 2-*O*-methylperlatolic acid (major), methyl 2-*O*-methylperlatolate (trace), stictic acid (minor), constictic acid (minor) and peristictic acid (trace).

Ecology—*Pertusaria loeiensis* is a rare, endemic, corticolous species known only from Nahaeo National Park, Loei Province, in northeastern Thailand.

COMMENTS—*Pertusaria loeiensis* is characterised by asci with two smooth ascospores and the presence of 2-*O*-methylperlatolic and stictic acids. The species is chemically similar to *P. tapadensis* (Elix et al. 1995a) but differs in the size of ascospores, 84–130 x 28–38 μm, compared to 125–140 (–175) x 40–60 μm in *P. tapadensis,* and in particular, the small black ostioles present in *P. loeiensis* compared to the larger, conspicuous black ostioles in *P. tapadensis* (cf. Elix *et al., loc. cit.*, p. 277, Fig 6). In addition *P. loeiensis* is corticolous whereas *P. tapadensis* grows on plant debris.

Pertusaria siamensis Jariangprasert *sp. nov.* **Figure 10**

Similis *Pertusaria planaica* A.W. Archer & Elix sed ascosporis majoribus.

Etymology: from the Latin *ensis*, place of origin, and Siam, the former name of Thailand.

Type: **THAILAND. Lampang Province**: Pban District, Tambon Jae Sawn, Jae Sawn National Park, behind the youth camp, opposite the waterfall, alt. 720 m, on *Shorea obtusa* Wall ex Blume, in dry dipterocarp forest, *S. Jariangprasert 3145*, 6.xi.2002; holotype: QBG.

KEY CHARACTERS—**Thallus** corticolous, dark olive green to grey green, surface partly subrugose to subtuberculate, shiny, with a distinct zonated margin, lacking isidia and soredia. **Apothecia** verruciform, conspicuous, hemispherical, concave above, constricted at base, not confluent, 0.6–1.2(–1.4) mm diam. **Ostioles** brown to black, conspicuous, sunken, some fused, in a central depression surrounded by greyish translucent tissue, 14 per apothecia, 18 per verruca. **Ascospores** 2–3, rarely 1 or 4, per ascus, ellipsoid, (86–)90–174(–204) μm long, (30–)36–54(–60) μm wide, smooth, inner wall trimmed, outer wall 8-16(-20) μm thick.

Chemistry—K+ pale yellow, KC-, C-, Pd-, UV-or whitish orange; 4,5-dichlorolichexanthone (minor) and planaic acid (major).

Ecology—*Pertusaria siamensis* is a common corticolous species found in National Parks in the northern, northeastern, northwestern and southwestern regions of Thailand at 200–1600 m. Reported substrates include *Dipterocarpus, Ficus, Shorea* and *Vatica.*

COMMENTS—*Pertusaria siamensis* is characterised by asci with two to three smooth ascospores and the presence of planaic acid and 4,5-dichlorolichexanthone. The new species is chemically identical to *P. planaica* but that species has eight, smaller ascospores, 80–100 x 25–35 μm (Archer & Elix 1992).

REPRESENTATIVE SPECIMENS EXAMINED- THAILAND. Chiang Rai Province: Phan District, Tambon Pa Hung, Doi Lhuang National Park, behind Doi Mhok, to Pang Pa Gluay and Pang Ma Kham Pom, on Fagaceae, in dry evergreen forest, *S. Jariangprasert 3591, 3597, 3653*, 14.xi.2002 (QBG).

Chiang Mai Province: Mueang District, Doi Suthep-Pui National Park, behind a community center of Ban Mong Moo 4, Ban Khun Chang Khian, *S. Jariangprasert 2616.1*, 16.ix.2002 (QBG); San Sai District, Ban Pa Phai, Ban Pong forest, *S. Jariangprasert 865*, 12.vi.2002 (QBG); Mae Rim District, The Queen Sirikit Botanic Garden, in dry dipterocarp forest, *K. Boonpragob s.n.*, 15.i.1995, RU 3731 (RAMK); Chiang Dao District, 1 km N of Ban Yang-Huey Ban RFD camp, on tree trunk, in dry dipterocarp forest on limestone outcrop, *D. Allan*, 18.x.1995, L 120 (CMU); *ibid.*, northern slope of Doi Sam Pi Nong Mountain, Doi Chiang Dao massif, on tree trunk, in young fallow field, *D. Allan*, 2.xi.1995, L 332 (CMU); Doi Chiang Dao National Park, the first ridge, in dry dipterocarp forest, *S. Jariangprasert 4095.1, 4098, 4154, 4173*, 3.xii.2002 (QBG); in dry dipterocarp forest, *S. Jariangprasert 4151.2*, 3.xii.2002 (QBG); *ibid.*, 600 m, on Fagaceae, *S. Jariangprasert 4112, 4115.2*, 3.xii.2002, (QBG); Huai Nam Dang National Park, 62-63 km, Noen Phee Lhok, 1300 m, on Fagaceae, in hill evergreen forest, *S. Jariangprasert 4416, 4418, 4459, 4466*, 24.xii.2002 (QBG); Omkoi District, Tambon Mon Jong, Ban Mae Toen, Omkoi Wildlife Sanctuary, Mon Hin Lhuang, in dry dipterocarp forest, *S. Jariangprasert 4337*, 18.xii.2002 (QBG); *ibid.*, breeding centre, Nangnon waterfall, in front of deer cage, in dry dipterocarp forest, *S. Jariangprasert 4341*, 18.xii.2002 (QBG).

Lampang Province: Pban District, Tambon Jae Sawn, Jae Sawn National Park, behind the youth camp, opposite of waterfall, in dry dipterocarp/hill evergreen forest, *S. Jariangprasert 3114*, 6.xi.2002 (QBG); *ibid., S. Jariangprasert, 3266*, 6.xi.2002 (QBG); *ibid.*, nature study track, near waterfall, in dry dipterocarp forest, *S. Jariangprasert 3035*, 5.xi.2002 (QBG).

Uttaradit Province: Nam Pad District, Ban Huai Mun, Phu Soi Dao National Park, behind waterfall, in dry dipterocarp/hill evergreen forest, *S. Jariangprasert 4068*, 28.xi.2002 (QBG); *ibid.*, to Huai Tao, Ban Coke, in dry dipterocarp forest, *S. Jariangprasert 3955, 3974, 3976, 4019, 4022*, 27.xi.2002 (QBG); *ibid.*, 400 m, on Fagaceae, in dry dipterocarp forest, *S. Jariangprasert 3985, 3986*, 27.xi.2002 (QBG).

Tak Province: Mueang District, Tambon Mae To, Lansang National Park, near waterfall, in dry dipterocarp forest, *S. Jariangprasert, 3662.1, 3669, 3670, 3672, 3678, 3686*, 19.xi.2002 (QBG).

Uthai Thani Province: Huai Kha Khaeng Wildlife Sanctuary, Huai Mae Dee, along a trail behind a building, 360 m, in dry dipterocarp forest, *S. Jariangprasert 1726*, 23.x.2001 (QBG); Khao Nang Rum, Cathouse site, in dry dipterocarp forest, *B. Aguirre-Hudson & P.A. Wolseley*, 7.i.1992, L 5282 (CMU).

Sakon Nakhon Province: Phu Phan National Park, Pha Nang Moen Cliff, in dry dipterocarp forest, *K. Vongshewarat*, 7.x.1997, RU 8970 (RAMK).

Kanchanaburi Province: Erawan National Park, a trail to Pa Lam Ton forest, in dry dipterocarp forest, *K. Vongshewarat*, 23.ix.1997, RU 8654.1, 8655, 8656 (RAMK).

Pertusaria thailandica Jariangprasert *sp. nov.* **Figure 11**

Similis *Pertusaria hermaka* A.W. Archer sed acida 2'-*O*-methydivaricaticum et 2'-*O*-methylstenosporicum continens.

Etymology: from the Latin, *ensis*, place of origin, and Thailand.

Type: **THAILAND. Chiang Mai Province**: Mueang District, Doi Suthep-Pui National Park, *Cinchona* plot, alt. 1100 m, on bark of *Cinchona*, in hill evergreen forest, *S. Jariangprasert 1539*, 1.vi.2001; holotype: QBG.

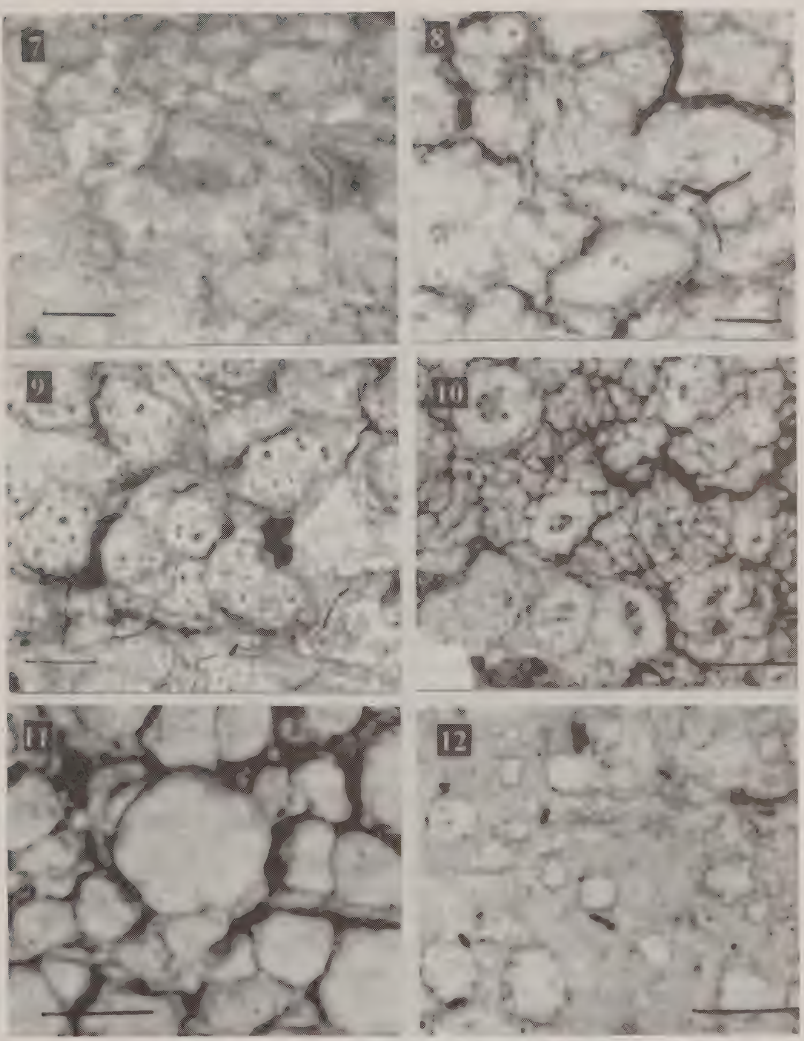


Figure 7-12. New species of *Pertusaria.* **7.** *P. kansriae*, holotype (QBG); **8.** *P. krabiensis*, holotype (PSU); **9.** *P. loeiensis*, holotype (RAMK); **10.** *P. siamensis*, holotype (QBG); **11** *P. thailandica*, holotype (QBG); **12**. *P. uttaraditensis*, holotype (QBG). Scale bar = 1.0 mm.

KEY CHARACTERS—Thallus corticolous, glaucous green to pale greyish green, surface smooth to subtuberculate, dull, isidia and soredia absent. **Apothecia** verruciform, conspicuous, numerous, scattered to crowded, flattened hemispherical, paler above, some irregular in outline, 0.3–1.5 mm diam. **Ostioles** hyaline to grey.

inconspicuous, flat, rarely poriform, 1 to many per verruca. **Ascospores** 3–4 per ascus, uniseriate, subfusiform to ellipsoid, 80–108 μm long, 34–44 μm wide, smooth; inner wall trimmed outer wall 6–10 μm thick.

Chemistry—K+ yellow, KC-, C-, Pd+ orange, UV+ slightly pale orange to orange; 4,5-dichlorolichexanthone (minor-trace), 2'-*O*-methylstenosporic acid (major), 2'-*O*-methyldivaricatic acid (minor), 2'-*O*-methylperlatolic acid (minor-trace), stictic acid (minor), constictic acid (minor), ±atranorin (minor) and ±chloroatranorin (minor).

Ecology— *Pertusaria thailandica* is a common corticolous species found in National Parks in the northern, northeastern and eastern regions of Thailand at 900–1700 m, on a variety of substrates including *Artocarpus, Betula, Castanopsis, Cinchona, Dalbergia, Eurya, Ficus, Lithocarpus, Mangifera, Phyllanthus, Prunus, Senna* and *Trema.*

COMMENTS—*Pertusaria thailandica* is characterised by asci with four smooth ascospores and the presence of lower homologues of 2'-*O*-methylperlatolic acid. It resembles *P. hermaka* Archer (Archer 1991) but the major depside in that species is 2'-*O*-methylperlatolic acid.

REPRESENTATIVE SPECIMENS EXAMINED- THAILAND. Chiang Rai Province: Phan District, Tambon Pa Hung, Doi Lhuang National Park, Ban Pang Pu Lo, in old mango orchard, *S. Jariangprasert 3432, 3435, 3436, 3444,* 13.xi.2002 (QBG); *ibid.,* 1180-1220 m, on Fagaceae, *S. Jariangprasert 3464, 3501, 3519*, 13.xi.2002 (QBG).

Chiang Mai Province: Mueang District, Doi Suthep-Pui National Park, track to top of mountain, on tree trunk, in moist evergreen forest, *S. Jariangprasert 1674*, 16.vii.2001, (QBG); Chiang Dao District, Huai Nam Dang National Park, 62-63 km, Noen Phee Lhok, on Fagaceae, in hill evergreen forest, *S. Jariangprasert 4452, 4461.2, 4475,* 24.xii.2002 (QBG); *ibid* in hill evergreen forest, *S. Jariangprasert 4483, 4484, 4490,* 24.xii.2002 (QBG); *ibidS. Jariangprasert 4493.2,* 24.xii.2002 (QBG); *ibid.,* parking area of Sone Doi, in hill evergreen forest with pine, *S. Jariangprasert 4510,* 24.xii.2002 (QBG); *ibid.,* look-out, on Euphorbiaceae, *S. Jariangprasert 4641, 4642*, 25.xii.2002 (QBG); *ibid., S. Jariangprasert 4677, 4678*, 25.xii.2002 (QBG); *ibid.,* by side of road to the new palace, in hill evergreen forest with pine, *S. Jariangprasert 4684.1,* 25.xii.2002 (QBG); *ibid.,* around the new palace, *S. Jariangprasert 4697,* 25.xii.2002 (QBG); *ibid.,* around sawmill, on woodpile, *S. Jariangprasert 4714,* 25.xii.2002 (QBG); *ibid.,* behind welfare shop, on high slope next to road to Ban Lee So, in front of welfare restaurant, *S. Jariangprasert 4761.1,* 25.xii.2002 (QBG); *ibid., S. Jariangprasert 4707.1*, 25.xii.2002 (QBG); Omkoi District, Tambon Mon Jong, Ban Mae Toen, Omkoi Wildlife Sanctuary, gateway to Musoe unit, in hill evergreen forest with pine, *S. Jariangprasert 4240, 4246.1,* 17.xii.2002 (QBG); *ibid., S. Jariangprasert 4299,* 17.xii.2002 (QBG); *ibid.,* 1300 m, on Fagaceae log, by side of road, *S. Jariangprasert 4300,* 17.xii.2002 (QBG); *ibid.,* on Mon Hin Lhuang, in dry dipterocarp forest, *S. Jariangprasert 4334.2*, 18.xii.2002 (QBG).

Tak Province: Mueang District, Tambon Mae To, Lan Sang National Park, between Tak Province and Mae Sod District, on the way to Musoe Dam and Musoe Lhueang Agricultural Station, trail to Pha Daeng unit, on tree trunk, in hill evergreen forest, *S. Jariangprasert 3712,* 20.xi.2002 (QBG); *ibid*, on Leguminosae, *S. Jariangprasert 3761.2,* 20.xi.2002 (QBG); *ibid., S. Jariangprasert 3839, 3851,* 20.xi.2002 (QBG).

Phitsanulok Province: Nakhon Thai District, Phu Hin Rongkla National Park, along roadside to guest houses, in pine plantation, *S. Jariangprasert 2110*, 20.i.2002 (QBG); *ibid.*, behind of Ban Pha Chu Thong guest house, *S. Jariangprasert 2125*, 20.i.2002 (QBG); *ibid.*, left hand side of Gan Thang Nakhon Thai 2, in pine plantation, *S. Jariangprasert*

1995, 19.i.2002 (QBG); *ibid.*, opposite of Gan Tang Nakhon Thai 2, on bark of unidentified tree, in pine plantation, *S. Jariangprasert 1967, 1998, 2000, 2003, 2005, 2006, 2008, 2018, 2019.1, 2033, 2036, 2037, 2039, 2040,* 19.i.2002 (QBG); *ibid.*, right hand side of the bronze Buddha, opposite the headquarters, in pine plantation, *S. Jariangprasert 1890, 1905, 1912, 1914, 1919.1, 1920,* 19.i.2002 (QBG); *ibid.*, opposite the headquarters, on unidentified tree, in pine plantation, *S. Jariangprasert 1933-1935, 1937-1939*, 19.i.2002 (QBG).

Loei Province: Phu Luang Wildlife Sanctuary, left hand side of trail to Channel 7 station, in oak/dipterocarp forest, *S. Jariangprasert 2302,* 4.ii.2002 (QBG); *ibid.*, left hand side before slope to Pha Somdej Cliff, on unidentified tree in scrub forest, *S. Jariangprasert 2263*, 3.ii.2002 (QBG), *ibid.*, at Pha Somdej Cliff, in scrub forest, *S. Jariangprasert 2272*, 3.ii.2002 (QBG).

Nakhon Ratchasima Province: Khao Yai National Park, Khao Khiao, along roadside to Pha Trom Jai Cliff, before a military post, on bark of Fagaceae, in dry evergreen forest, *S. Jariangprasert 1392, 1411, 1416, 1417,* 17.xii.2000 (QBG); *ibid.*, along a trail to Pha Diao Dai Cliff, in dry evergreen forest, *S. Jariangprasert 1480, 1484, 1491, 1498,* 17.xii.2000 (QBG).

Pertusaria uttaraditensis Jariangprasert *sp. nov.* **Figure 12**

Similis *Pertusaria salebrosa* A.W. Archer & Elix sed thallo corticola vice saxicola et acidum 2'-*O*-methylperlatolicum continens vice acida 2-*O*-methylsuperlatolicum et 2'-O-methylhyperlatolicum continens differt.

Etymology: from the Latin *ensis,* place of origin, and Uttaradit Province.

Type: **THAILAND. Uttaradit Province**: Nam Pad District, Ban Huai Mun, Phu Soi Dao National Park, final mountain slope behind waterfall, alt. 1020 m, on fetid vine, before dry dipterocarp/ Fagaceae forest, *S. Jariangprasert 4054,* 28.xi.2002 holotype: QBG.

KEY CHARACTERS—Thallus corticolous, olive green, surface smooth and dull, sorediate; isidia absent. **Soredia** off-white, farinose, distinctly disciform, scattered, 0.2–0.7 mm diam. **Apothecia** unknown.

Chemistry—K-, KC-, C-, Pd-, UV-; 2´-*O*-methylperlatolic acid (major).

Ecology—*Pertusaria uttaraditensis* is a rare endemic sorediate, corticolous species known only from the type specimen from Uttaradit Province in northern Thailand.

COMMENTS—*Pertusaria uttaraditensis* is characterised by the sorediate thallus and the presence of the single depside, 2´-*O*-methylperlatolic acid. It is distinguished from the morphologically and chemically similar species *P. salebrosa* A.W. Archer & Elix (Archer 1997*)* by the absence of the higher homologues of 2'-*O*-methylperlatolic acid, present in *P. salebrosa.*

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New records of morels from Turkey

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Abstract— Numerous field trips in Muğla Province during 2000 and 2002 revealed four *Morchella* taxa new to Turkey. *Morchella elatoides* var. *elegans, M. hortensis, M. pseudoviridis,* and *M. purpurascens* var. *ionoviridis* are described and illustrated.

Key words— taxonomy, Turkish fungi, macromycetes

Introduction

Many species of *Morchella* are exported to foreign countries from Turkey, in particular France, Sweden, Germany, England, Belgium, Netherland and the United States. As a result, morels from the Aegean, Mediterranean and Marmara regions contribute significantly to the Turkish economy. In Muğla Province ecological factors, such as a mild, rainy regime on the coastal and cooler interior regions particularly foster *Morchella* diversity (*Fig. 1*). In Muğla morels can be collected from February to May in sunny places in pine forests, especially in burned areas, clearings, or on woody debris such as bark chips, sawdust, or wood chippings. Morels are but also found in gardens, lawns and parks.

Many studies on macromycota have been done in Turkey (Mat 2000, Solak et al. 2001, 2002). Clearly many mushrooms growing in different parts of Turkey have not yet been determined. About 300 articles published between 1932 and 2004 have been examined. About 1400 macrofungus species have thus far been reported from Turkey. Among these, 22 *Morchella* taxa have been recorded.

This study adds four new *Morchella* taxa to the Turkish Macromycota, increasing the known taxa from 22 to 26.

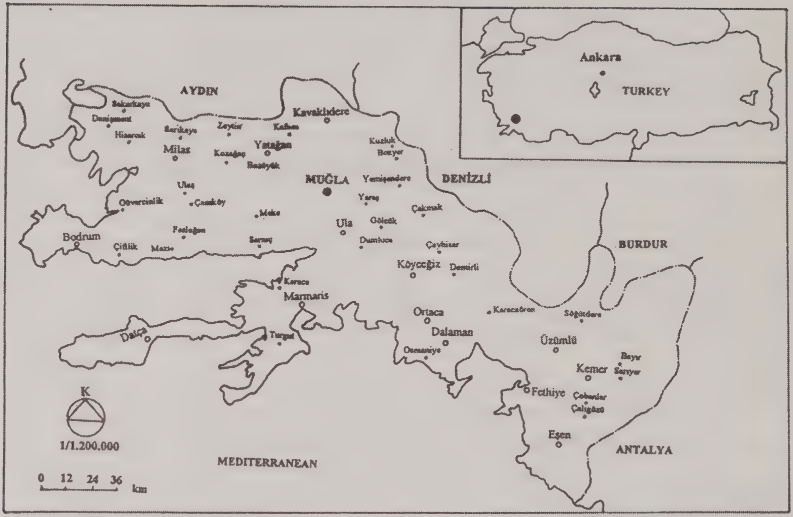
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FIGURE 1. Muğla Province, the study area.

Materials and Methods

Specimens were collected during field trips in Muğla Province between 2000 and 2002. The morphological and ecological characteristics of the macrofungi were recorded. The morels were first photographed in their natural habitats and then brought to the laboratory. Spore prints were taken and fresh ascospores were photographed. Dried specimens were numbered, placed in locked bags, and frozen at low temperatures for a week to protect against internal and external parasites.

The specimens were identified using macroscopic and microscopic features, using references by Marchand (1973), Breitenbach & Kranzlin (1984), and Jacquetant (1984). All specimens collected are now curated at the fungarium of Muğla University.

Taxonomic Descriptions

Morchella elatoides Jacquet. var. ***elegans*** Jacquet. **Figure 2**

Cap 40-50 x 20-25 mm, cylindrical, thin and tall, breakable; longitudinal ribs yellowish, sometimes dark yellow, usually with 10 ribs, narrow at edges. Alveolae irregular and dimension variable. **Stalk** 20 x 10 mm, shorter than cap, cylindrical; surface white to

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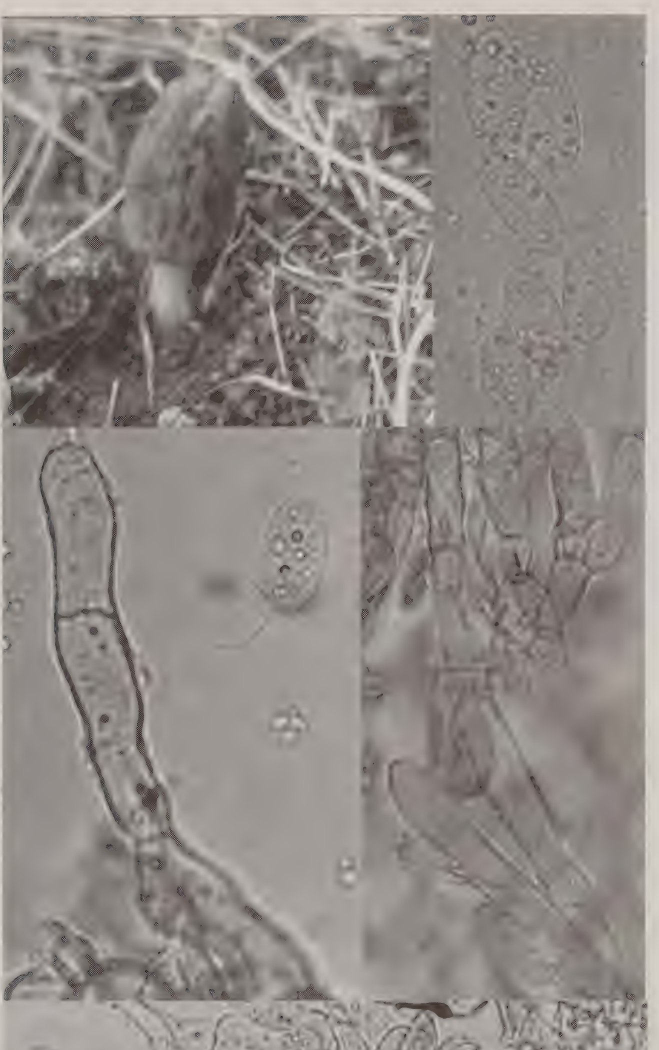
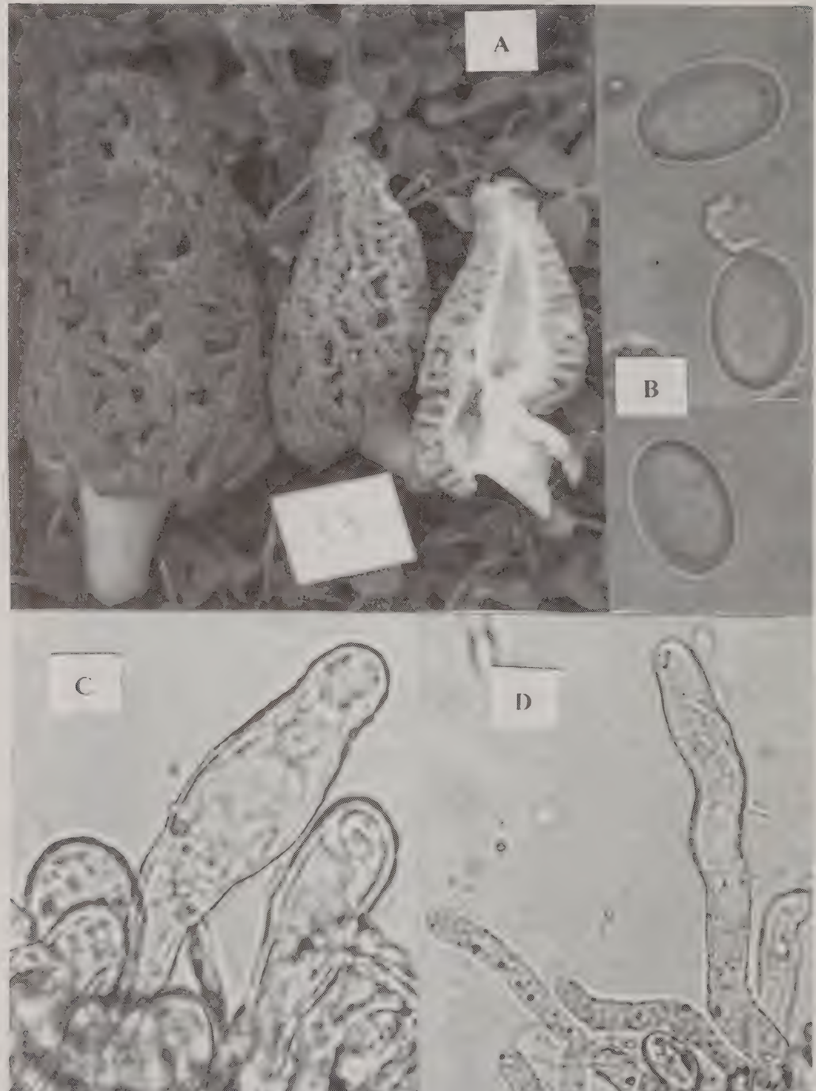
FIGURE 2 *Morchella elatoides* var. *elegans*. **Top left.** Fruiting body *in situ*. **Top right.** Ascospores (×400). **Middle.** Paraphyses (left ×400; right ×200). **Bottom:** Cystidia (×200).




A
B
C
D

ochraceous, wrinkled at base, furfuraceous; hollow. Margin of cap passing directly into the stalk without a sharp bend.

Spores 22.5 x 11-12.5 μ, elliptical, smooth. **Asci** eight-spored. **Paraphyses** cylindrical, septate and forked, tips with clavate thickenings. **Cystidia** rather regular, clavate.

Habitat under *Pinus* and *Quercus* and open places in the forest.

Distribution Muğla, Yaras Village, 17.04.2001, FY., S., 6; Yemisendere Village, 17.04.2001, FY., S., 63.

M. hortensis Boud. FIGURE 3–4

Cap 45-60 x 30-35 mm, ovoid, rarely cylindrical, light brown to grey; ribs thick, frequently, whitish, usually 20-30 irregular longitidunal ribs, alveolae darker than ribs. **Stalk** 25-35 x 10-15 mm, always shorter than cap, cylindrical, broadened toward the base; white to cream, surface wavy, hairy, hollow. Margin of cap sharply bent inward and attached to stalk. **Flesh** whitish, thin.

Spores 22-23 x 15-16 μ, elliptical, hyaline. **Paraphyses** cylindrical, branched, thickened at the tips. **Cystidia** regular, broad clavate.

Habitat near the pathway outside the forest.

Distribution Mugla, Ula, Golcuk Village, 11.04.2001, FY., S., 31,33,35.

M. pseudoviridis Jacquet. FIGURES 4–6

Cap 40-60 mm, irregularly spherical to oval, ribs thin and irregular; light golden yellow, alveolae large, irregular, deep, grey to light brown. **Stalk** 20-30 x 15 mm, cylindrical, thickened toward the base; white; surface smooth to slightly wrinkled, hollow.

Spores 20-22.5 x 10-12.5 μ, elliptical, smooth, sometimes with small droblets. **Asci** eight spored, turning reddish in Melzer's Reagent. **Paraphyses** cylindrical and septate. **Cystidia** irregular.

Habitat in broadleaved forest.

Distribution Muğla, Milas, Sakarkaya Village, 10.04.2001, FY., S., 42.

M. purpurascens (Kromb. ex Boud.) Jacquet. var. ***ionoviridis*** Jacquet. FIGURE 6–7

Cap 40-60 x 25-35 mm, conic, longitudinal ribs thick, distance between ribs narrow, alveolae small; purplish. **Stalk** 15-25 x 10 mm, small, thick, white to pale grey. Margin of cap is sharply bent inward and attached to stalk.

FIGURE 3. *Morchella hortensis.* **A.** Fruiting body in situ. **B.** Ascospores (×400) **C–D.** Paraphyses (C: ×400, D: ×200).

Spores 23-25 x 14-15 μ, narrow elliptical to ovoid. **Asci** eight spored. **Paraphyses** clavate shaped. **Cystidia** long, bulky and regular.

Habitat in coniferous forest.

Distribution Mugla, Dalaman, Osmaniye Village, 15.04.2001, F.Y., S., 81.

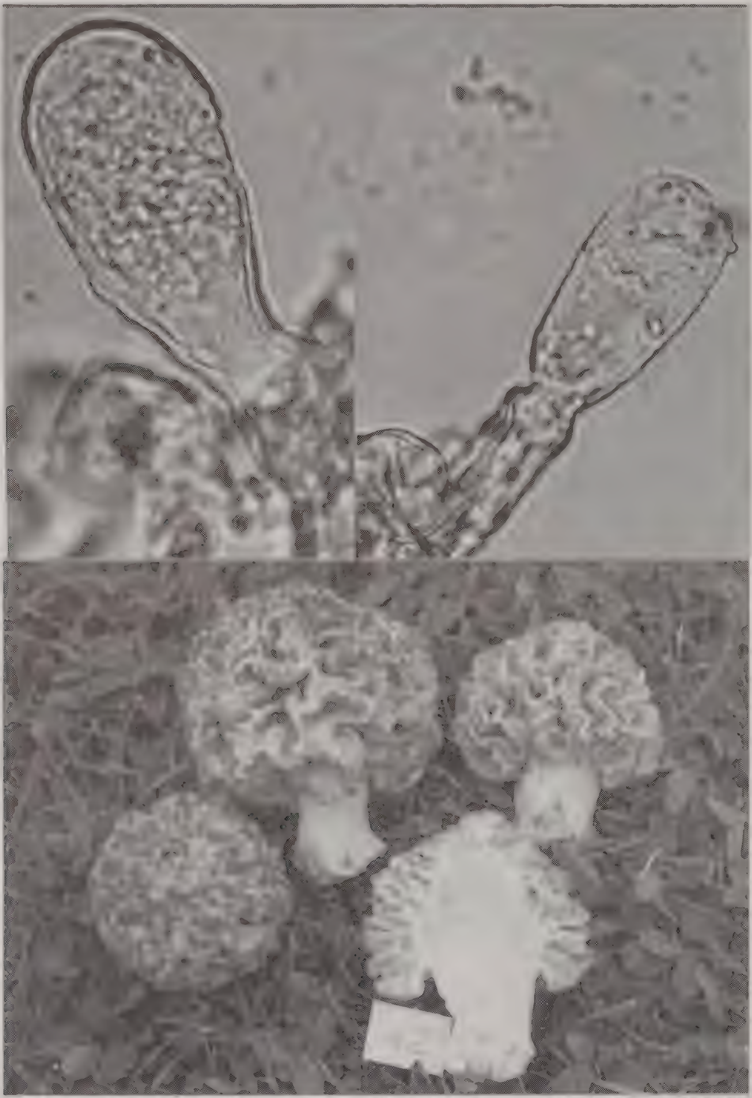


FIGURE 4. **Top:** *Morchella hortensis*. Cystidia (×400) **Bottom:** *Morchella pseudoviridis*. Fruiting body (×0.75).

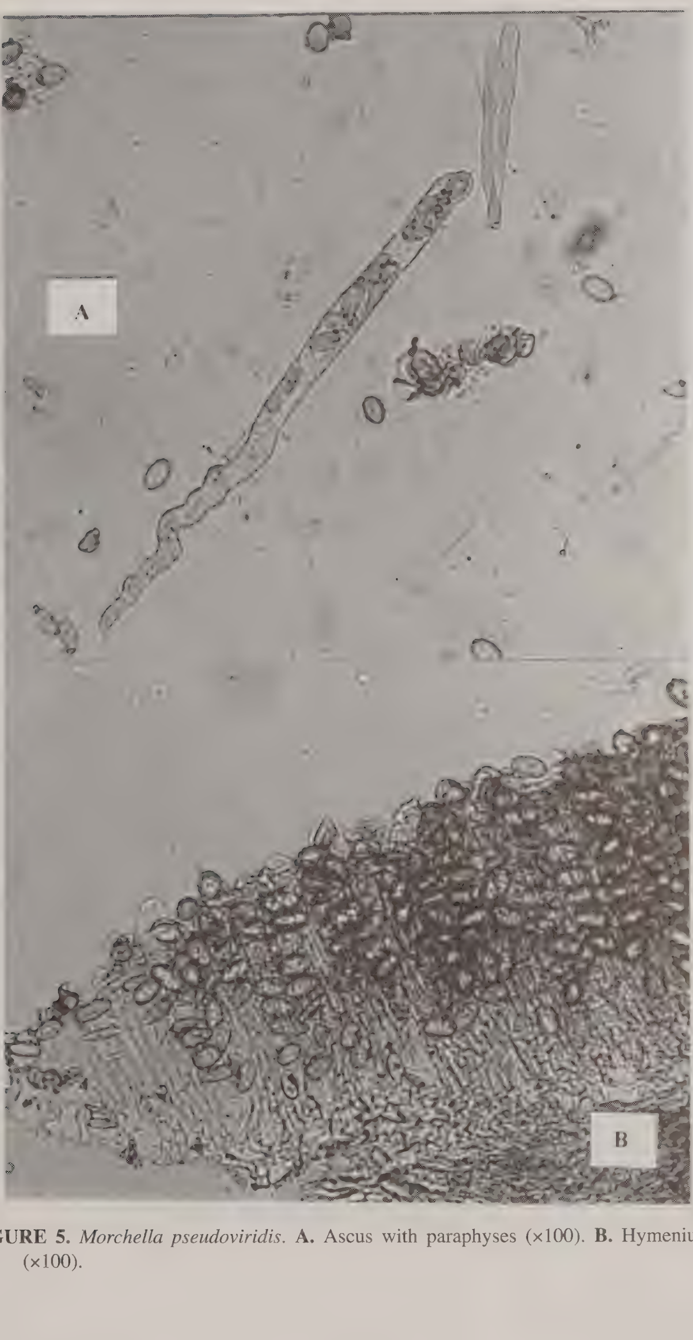


FIGURE 5. *Morchella pseudoviridis*. **A.** Ascus with paraphyses (×100). **B.** Hymenium (×100).

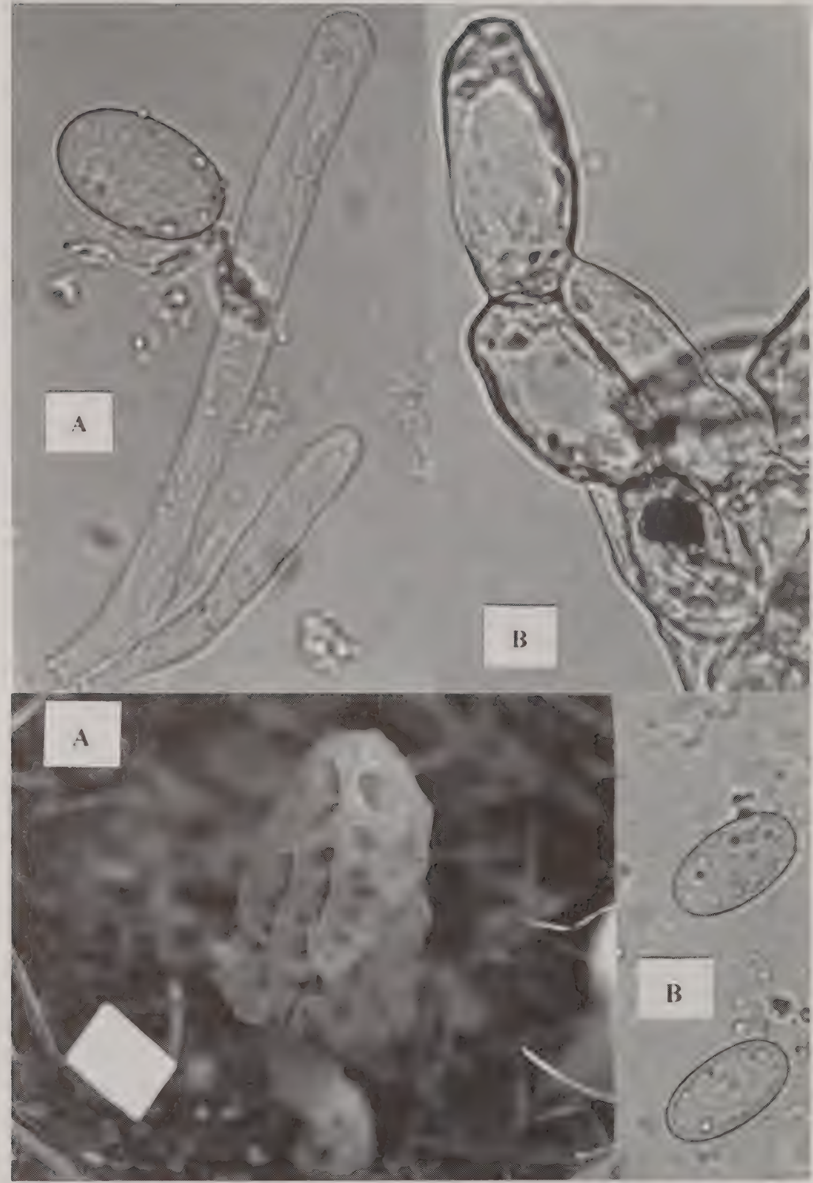


FIGURE 6. Top. *Morchella pseudoviridis*. **A.** Paraphyses (×400). **B.** Cystidia (×400). **Bottom.** *Morchella purpurascens* var. *ionoviridis*. **A.** Fruiting body in situ (×1). **B.** Ascospores (×400).

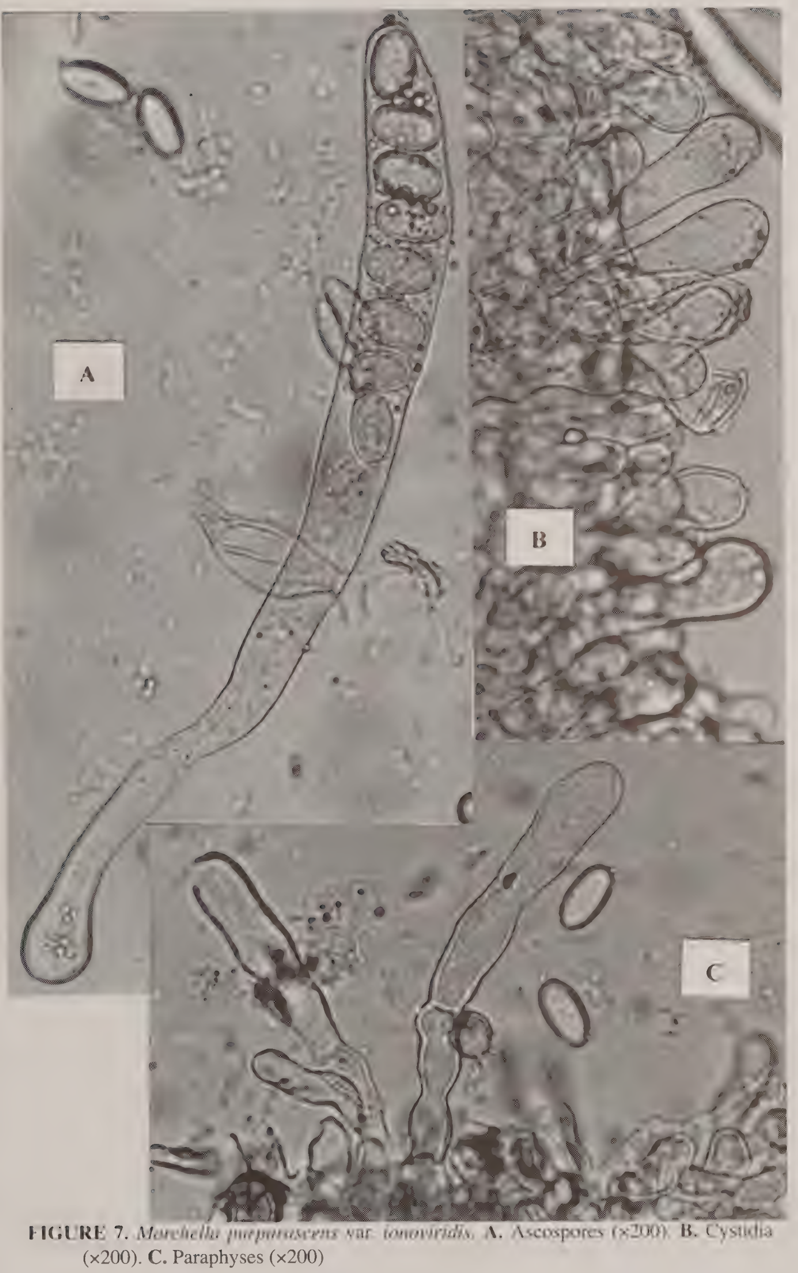


FIGURE 7. *Morchella purpurascens* var. *ionoviridis.* **A.** Ascospores (×200). **B.** Cystidia (×200). **C.** Paraphyses (×200)

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Leucoagaricus bivelatus, a new volvate lepiotoid species

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Abstract—*Leucoagaricus bivelatus,* a species with a membranous universal veil, is described as new from Panamá. It is similar to the European species *Leucoagaricus volvatus,* but has narrower, shorter basidiospores and narrower cheilocystidia.

Keywords—taxonomy, *Agaricaceae*, systematics

Introduction

Most lepiotoid fungi lack a well-developed universal veil that leaves remnants such as a distinct volva or warts on the pileus. A few exceptions are known, however. These include *Smithiomyces mexicanus* (Murrill) Singer, originally described as *Leucomyces mexicanus* Murrill (Singer 1986, Murrill 1911); *Clarkeinda trachodes* (Berk.) Singer; and species in *Volvolepiota* Singer (Singer 1986), recently synonymized with *Macrolepiota* Singer (Vellinga & Yang 2003).

Bon and Caballero (1995) described a new volvate species from Spain in the genus *Leucoagaricus* (Locq.) Singer. This was the first such species recognized in *Leucoagaricus,* and the only one known until now. The present paper describes a newly discovered volvate species of *Leucoagaricus* from Barro Colorado Island, Panamá, collected in 2000 by C. Ovrebo. For details on the Barro Colorado Island locality, see Buyck and Ovrebo (2002).

Materials and Methods

Macroscopic observations on fresh basidiomes were made by C. Ovrebo. The color notations indicated in the description are from Kornerup and Wanscher (1978), and Anonymous (1992). Herbarium abbreviations used follow Holmgren et al. (1990).

Taxonomic authors are abbreviated according to Kirk and Ansell (1992), and abbreviations of Latin terms follow Stearn (1992).

For microscopic study, small tissue samples were excised, wetted in 95% ethanol, then revived in water. Sections were cut by hand and mounted in 3% KOH and Melzer's reagent, following standard mycological methods (Smith 1949; Largent *et al.* 1977; Singer 1986). Studies of micromorphological features were carried out at 400 and 1000 X, and line drawings were made using a Leitz drawing tube. Size ranges of elements were based on ocular micrometer measurements of at least 12-15 examples of each type from each collection studied. Wall thickness of the basidiospores is shown for only one example illustrated.

Results

Leucoagaricus bivelatus B.P. Akers & Ovrebo **Figs. 1-2**

> Species haec a *Leucoagarico volvato* praesertim differt sporis, (4.1) 4.5-8 x 3.3-4.8 μm (non [6] 6.5-8.5 [9] x [4] 4.5-5.5 [6] μm), et cheilocystidia clavata vel subclavata (non clavata vel ventricoso-fusiformia). HOLOTYPUS: Ovrebo 3897, PMA.

Macromorphological features. **Pileus** 70-90 mm broad, elliptical at first, concave with low umbo when expanded; surface with pileus cuticle tomentose to radially fibrillose, covering nearly all at first and remaining undiffracted at disc, elsewhere diffracting radially with expansion about halfway to the disc and receding some from pileus margin, exposing pileus context beneath, context off-white, margin becoming rimose and radially plicate, plications extending to subdiscal region; fibrils of pileus cuticle dark bluish to black, extending from disc to about half the radius; context up to 2 mm thick, off-white. **Lamellae** 5-8 mm broad, free, off-white, not discoloring, crowded. **Stipe** 115-150 mm long, 5-8 mm wide, equal but slightly enlarged at base, glabrous-sericeous, off-white, not discoloring, hollow. **Partial veil** membranous, forming persistent, membranous, upwardly-flaring annulus. **Volva** membranous, saccate-peronate, closely sheathing base of stipe, up to 35 mm high, off-white but slightly discolored with clinging soil. **Odor and taste** distinctive but not identifiable.

Micromorphological features. **Basidiospores** (4.1) 4.5-8 x 3.3-4.8 μm (Q = 1.51); ellipsoidal to ovoid, smooth, wall thick (0.5 μm), germ pore absent but spore wall thinning at the apex; hyaline in KOH, moderately dextrinoid (rusty orange with yellow perispore in Melzer's reagent), metachromatic. **Basidia** 18-30 x 6-10 μm; narrowly to broadly clavate, sometimes slightly swollen just above the middle, tetrasterigmate; basidioles ranging smaller, down to 11 x 5 μm, variably clavate; all hymenial elements hyaline in KOH. **Cheilocystidia** 21-49 x 7-20 μm, abundant, clavate to irregularly subclavate, often with pedicel 6-23.5 x 4-10.5 μm; apices sometimes slightly mucilaginous with adherent fine debris; hyaline in KOH. **Pleurocystidia** lacking. **Hymenophoral trama** irregularly parallel to slightly interwoven, hyphae filamentous, septate, diameter up to 15 μm near origin of lamellae, down to 5 μm near edge of lamellae, elements cylindric-inflated, 25-80 μm in length; hyaline in KOH. **Pileipellis** of filamentous hyphae, septate to articulated, +/- straight to flexuous to

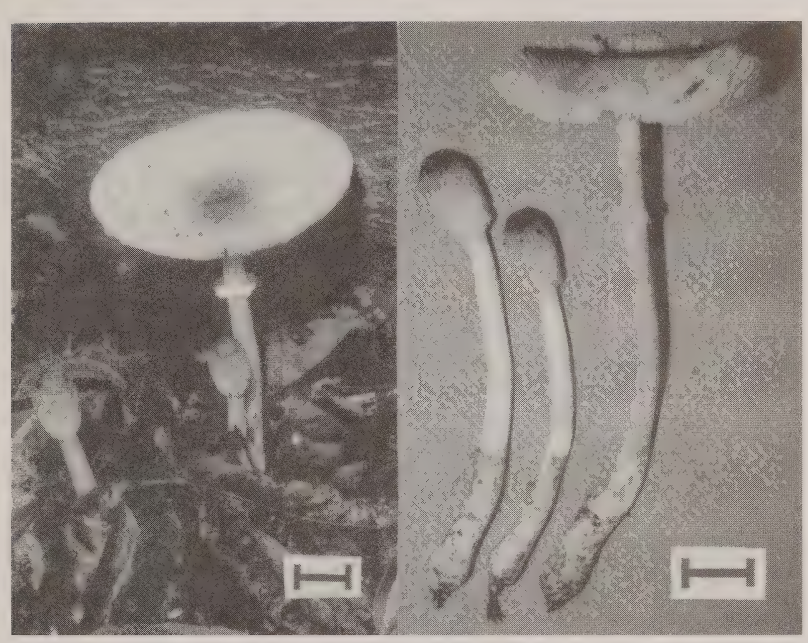

Fig. 1. *Leucoagaricus bivelatus* B.P. Akers and Ovrebo, sp. nov., (holotype). Scale bars = 2 cm.

abruptly meandering-angled, +/- erect to arching or descending to prostrate, parallel to interwoven, diameter 5-12(20) μm, elements subcylindric to allantoid, slightly inflated, length 10-75 μm, occasionally bifurcate, or with short, peg-like branches, terminal elements not differentiated except by apex evenly rounded not truncate; most elements with vacuolar pigment, finely vesiculose-granulose, pale grey in KOH, dull yellowish in Melzer's reagent; other elements hyaline with homogeneous nongranulose cytoplasm; yet other elements conspicuously dull golden in KOH, with heterogeneous-vesiculose cytoplasm; occasional refractive elements in pileipellis and supporting trama; trama hyaline in KOH, hyaline to pale orange in Melzer's reagent. **Stipitipellis** of filamentous hyphae, diameter 3-6 μm, appressed, smooth, thin-walled; caulocystidia absent. **Stipe trama** of filamentous hyphae, diameter 4-12 μm, thin-walled. **Annulus** of filamentous hyphae, septate; hyphae of annulus margin differentiated, diameter 4-7 μm, elements 50-100 μm long, some hyaline, others brown and often translucent-refractive in KOH; other hyphae of annulus undifferentiated, diameter 12-26 μm, elements 30-60 μm long, slightly inflated, hyaline in KOH. **Volva** of filamentous hyphae, diameter 3-10 μm, septate, thin-walled, hyaline in KOH, smooth, elements cylindric. **Clamp connections** absent.

Collections studied. PANAMA. Terrestrial, scattered on soil (two buttons and one fully developed basidiome), near "Big Tree" off of Van Tyne Trail, 26 May 2000, Ovrebo 3897 (holotype, PMA). Terrestrial, solitary, Miller Trail, 28 May 2000, Ovrebo 3910 (PMA).

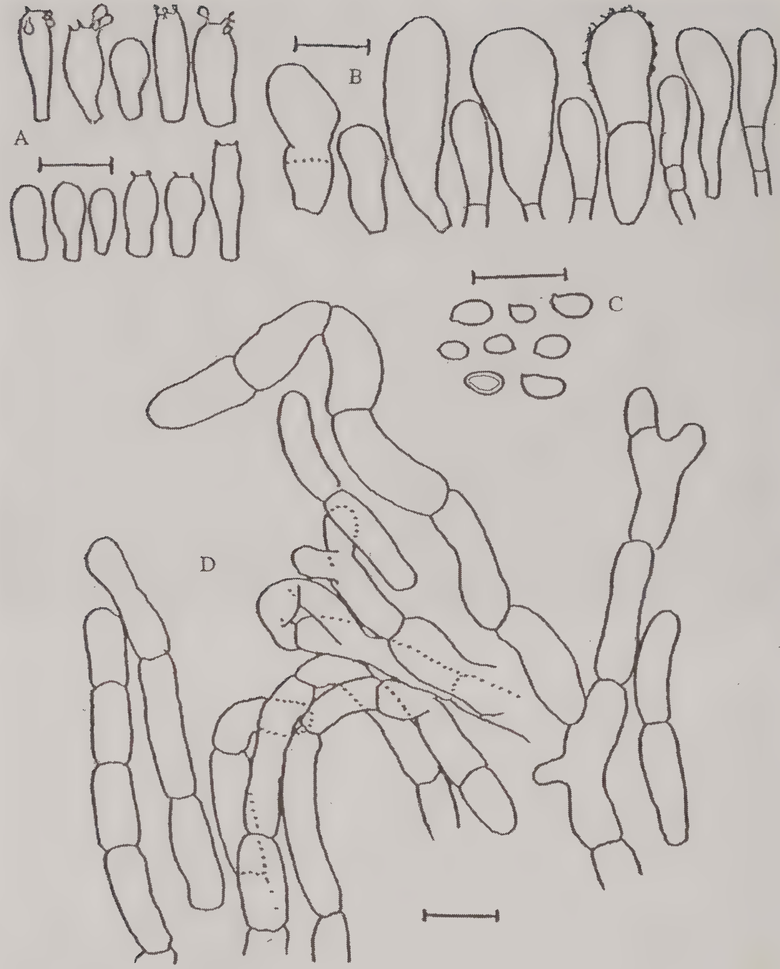

Fig. 2. Micromorphology of *Leucoagaricus bivelatus* B.P. Akers & Ovrebo. A. Basidia and basidioles. B. Cheilocystidia. C. Basidiospores. All illustrations PMA Ovrebo 3397. Scale bars = 20 μm.

Discussion

This species appears to be closely related to *Leucoagaricus volvatus* Bon & Caball. Based on the description of *L. volvatus* (Bon and Caballero 1995), its basidiospores are somewhat longer and wider than those of *L. bivelatus,* but similar in shape and other features. Both of these species have a fibrillose pileipellis, and differ from *Volvolepiota* in having nonporate basidiospores and a more gracile habit or stature.

Cheilocystidia also differ significantly between these two volvate *Leucoagaricus* species. According to Bon and Caballero (1995), *L. volvatus* has comparatively narrow, clavate to fusiform cheilocystidia, no more than (6)8-10(12) μm in width. *L. bivelatus* has much more broadly clavate cheilocystidia, up to 20 μm in width. Coloration of the pileipellis also appears to differ between these two species. Bon and Caballero (1995) reported *L. volvatus* has a faded yellowish cream to olivaceous fuliginous disc, whereas *L. bivelatus* displays a bluish black surface.

Apart from these species-level differences, especially in the basidiospores and cheilocystidia, various similarities of micro- and macromorphology suggest a close relationship between *L. volvatus* and *L. bivelatus*. The latter can almost be considered as a neotropical counterpart of the former. These two *Leucoagaricus* species are unique for this genus in having a distinct, well-formed volva, and probably belong to a natural group, recognizable perhaps at a sectional level.

Molecular analysis has not supported *Leucoagaricus* as a monophyletic genus (Johnson and Vilgalys 1998; Johnson 1999). It seems to consist of various species that do not belong in other genera of the leucocoprinean tribe as delineated by Singer (1986), Bon (1981), and other workers. The species described here as new is placed in *Leucoagaricus* with this understanding. No close relationship with taxa other than *L. volvatus* is inferred or implied.

Acknowledgments

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A new species of *Phallus* from China and *P. formosanus*, new to the mainland

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Abstract—The new species, *Phallus tenuissimus,* and *P. formosanus,* new to Mainland China, are described and illustrated. Both species were collected from within Yunnan Province, China: *P. tenuissimus* in the Wuliangshan Nature Reserve and *P. formosanus* in the Yingjiang Nature Reserve. A key to *Phallus* species known from China is also presented, and an interesting native Chinese species *Dictyophora nanchangensis* is discussed.

Key words—*Phallaceae, Phallales, Phallus nanchangensis, Phallus tenuis*

Introduction

In recent years, the authors have examined hundreds of specimens of *Phallus* deposited in the main fungal herbaria in mainland China, which has led to the development of a key to *Phallus* species. The specimens examined include nearly all the Chinese species mentioned by Chou (1954), Kobayasi (1938), Liu et al. (1982), Teng (1963), Tai (1979), Liu (1984), Zang et al. (1984), and Fan et al. (1994). The species covered include a species new to science as well as a new record for the mainland. Notes concerning interesting taxa reported in Li et al. (2002, 2003) are also included.

Key to the Chinese species of *Phallus*

1. Pileus nearly smooth, finely rugulose or granulose (sect. *Rugulosi*); basidiome reddish to red **2**
1. Pileus with raised reticulations (sect. *Reticulati*); basidiome white to yellow (pinkish in some species) **3**

2. Stipe with a red cylindrical sheath composed of 10-14 tubes .... ***P. taibeiensis*** B. Liu & Y.S.Bau
2. Stipe without a sheath .... ***P. rubicundus*** (Bosc)Fr.

3. Stipe robust, usually more than 4 cm thick, up to 6×8 cm, pinkish, with many small pores or holes through the stipe wall .... ***P. formosanus*** Kobayasi
3. Stipe thinner, less than 4 cm thick, without small holes **4**

4. Pileus large, 6-7.2 cm high and 4-5.5 cm broad when mature .... ***P. megacephalus*** M. Zang
4. Pileus smaller, less than 5.5 cm high **5**

5. Pileus white; stipe white, sometimes pale yellow to pinkish **6**
5. Pileus pale yellow, sulphur yellow to yellow; stipe often pale yellow or yellowish (occasionally white in certain species) **7**

6. Basidiospores large, 6-7.6 × 4-4.7 μm ..... ***P. macrosporus*** B. Liu, Z.Y. Li & Du
6. Basidiospores smaller, 3-3.8 (-4.5) μm long .... ***P. impudicus*** L.

7. With fragrant odour of lilac .... ***P. fragrans*** M. Zang
7. Without fragrant odour of lilac **8**

8. Stipe very slender, less than 5 mm thick .... ***P. tenuissimus*** T.H.Li, W.Q.Deng & B.Liu
8. Stipe thicker, more than 5 mm thick **9**

9. Basidiome less than 5 cm high .... ***P. sulphureus*** Lohwag
9. Basidiome more than 5 cm high **10**

10. Reticulum on pileus small and low, only 0.3-1 (-1.5) × 0.2-0.8 (-1.0) mm wide, 0.2-0.4 mm deep; stipe flabby .... ***P. tenuis*** (Fisch.) Kuntze
10. Reticulum on pileus larger and deeper than above; stipe relatively hard.. **11**

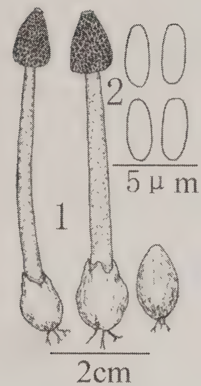
11. Growing on wood, pileus apex reflexed. . . ***P. costatus*** var. ***costatus*** (Penz.) Lloyd
11. Growing on ground **12**

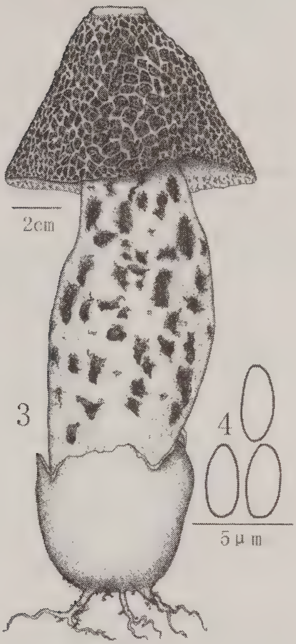
12. Pileus subglobose, margin obviously incurved; stipe deep coloured, yellow, pale yellow brown to pale orange brown .... ***P. costatus* var. *sphaerocephalus*** T.H. Li, B. Song & B. Liu
12. Pileus conical or nearly so, margin not incurved or only slightly so; stipe lighter coloured, yellowish to pale yellow **13**

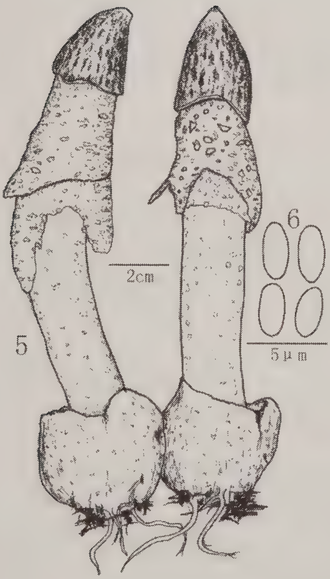
13. Pileus apex reflexed as a large disc......... ***P. costatus* var. *epigaeus*** Kobayasi
13. Pileus apex reflexed as a pendulous margined disc .... ***P. costatus* var. *dailingensis*** Y.L.Chou

Taxonomic Descriptions

Among the 14 taxa mentioned in the key, ***Phallus tenuissimus*** is a new species to science while ***P. formosanus*** is a new record to Mainland China. Colour references follow Kornerup and Wanscher (1978). HBDJU refers to the Herbarium of Botanical Department at Jiangxi University; HMIGD represents the Herbarium of Guangdong Institute of Microbiology.







Figs. 1-2 *Phallus tenuissimus*. 1. Basidiomes, 2. Basidiospores. (HKAS 32922)
Figs.3-4 *Phallus formosanus*. 3. Basidiome, 4. Basidiospores. (MHSFC 0598)
Figs. 5-6 *Dictyophora nanchangensis*. 5. Basidiomes, 6. Basidiospores. (HBDJU 87010)

Phallus tenuissimus T. H. Li, W. Q. Deng & B. Liu, *sp. nov.* **Figs.1-2**

> *Basidioma juvenilis globosa vel ovata, 0.5-1.2 cm alta, 0.4-0.8 cm lata, alba vel flavida, aliquando dilute flava, rhizomorphis albidis ad basin; basidioma matura (3-) 5-7.5 cm alta. Pileus conicus vel campanulatus, 0.8-1.5 (-2) cm altus, 0.4-0.7 cm latus, dilute flavus, flavus vel griseolo-flavus et olivaceo-flavus, apice truncates leviter collari, ad superficiem reticulatus maculis iraequaliter multangulis 0.3-1 (-1.5) × 0.2-0.8 (-1.0) mm latis, 0.2-0.4 mm alti. Gleba olivaceo-fusca, mucilagina, foetida. Stipes cylindraceus, praegracilis, (3-) 5-7 cm longus, 2-4 mm latus, flaccidus, fistulosus, dilute flavus vel pallide fulvus, spongiosus, ad superficiem leniter reticulatus vel alveolus in parte. Volva albida vel dilute flavida. Basidiosporae cylindriceae, 3.3-4 × 1.1-1.4 μm, olivaceo-hyalinae, laeves.*

Unexpanded *basidiome* globose to ovoid, 0.5-1.2 cm high, 0.4-0.8 cm wide, white to yellowish (3A1 to 3A2), sometimes pale yellow (3A3), with white rhizomorphs at base; mature *basidiome* (3-) 5-7.5 cm high. *Receptacle* composed of a pileus and a stipe. *Pileus* conical to campanulate, 0.8-1.5 (-2) cm high and 0.4-0.7 cm broad, covered with gleba on surface, pale yellow, yellow to greyish or greenish yellow (3A4, 3A5, A6 to 3B5) where exposed, perforate at apex, reticulate on surface; meshes obvious but shallow and small, irregularly polygonal, 0.3-1 (-1.5) × 0.2-0.8 (-1.0) mm, 0.2-0.4 mm deep. *Gleba* on pileus surface, dark greenish brown to olivaceous brown (3E6, 4D5 to 4E6), mucilaginous, foetid. *Stipe* cylindrical, very slender, (3-) 5-7 cm long, 2-4 mm thick, pale yellow (3A3 to 3A4), slightly deeper coloured (4A5) when dried, hollow, spongiose, flabby, wall composed of chambers which are mostly open outwards, nearly reticulate to shallowly alveolate on surface. *Volva* white to pale yellow (3A1 to A2). *Basidiospores* cylindrical, 3.3-4 × 1.1-1.4 μm, light olivaceous to subhyaline, smooth.

Hab.: gregarious to caespitose on the ground in forests.

SPECIMEN EXAMINED: CHINA. YUNNAN Province: Jingdong County. *WULIANGSHAN NATURE RESERVE—1.VIII.1998, X. H. Wang 594 (HKAS 32922,* ***holotype****).*

The new species because of the reticulate pileus is a member of sect. *Reticulati*. It is quite similar to another yellow and flabby species *Phallus tenuis*, but the latter has much larger basidiomes with its stipe 10-12 mm thick near the base (Saccardo 1888). The spores of the new species are also narrower than those of the latter.

Phallus formosanus Kobayasi, Nova Fl. Jap.-*Hymenogastrineae* et *Phallineae*. p.73,1938 **Figs.3-4**

Ithyphallus roseus Sawada, Trans. Nat. Hist. Soc. Formosa 19: 35, 1929; Cat. Formosan Fungi. 5: 92, pl. 5, 1931.

Unexpanded *basidiome* globose to ovoid, white to yellowish white (4A1 to 4A2). *Peridium* becoming a volva when mature. Volva coloured as the unexpanded basidiome, but partially light orange to brownish orange (5A4, 5A5, 5B4, 5B5 to 5C5) where the white exoperidium falls off, becoming orange brown to pale brown (7C7 to 7D7) when dried. *Stipe* pinkish white to pink (7A2 to 8A2), subcylindrical to subfusoid, robust, < 25 cm long, 8 cm thick at the thickest middle portion, spongiose, hollow, with many (about 100) irregularly formed pores (1-2 cm wide) through stipe wall. Pileus conical, 8 cm high, 10 cm wide, with distinct irregularly polygonal reticulation with meshes 2-6 mm wide and < 6 mm deep, covered with dark mucilaginous gleba, concolorous (7A2 to 8A2) with stipe lacking gleba, or partially brownish orange (6C6), then becoming pale brown to brown (7C7, 7D6 to 7D7). Gleba mucilaginous, greyish olivaceous, dark olivaceous to nearly blackish brown (28C6 to 28F5 or 28F4), foetid. Basidiospores slightly olivaceous, subcylindrical to ellipsoid, 3-3.5 × 1.2-1.5 μm, smooth.

Hab.: solitary on the ground in forests.

SPECIMEN EXAMINED: CHINA. YUNNAN Province: Yingjiang County, *TONGBIGUAN NATURE RESERVE– 25.IV.1995, F. Du 0598 (MHSFC 0598).*

This is a seldom seen but very distinctive Chinese native fungus, which was previously reported only from Taiwan. The collection from Yunnan has a robust basidiome, pinkish stipe and many pores through the stipe wall, which are identical to those of the Taiwanese specimen described and illustrated by Kobayasi (1938). With those characters it can be easily distinguished from any of other known phalloid fungi.

Other phalloids reported from China

The new name, *P. taibeiensis* (Liu & Bau 1982), should be used for *Phallus formosanus* W.S. Lee (1957), which is a later homonym of *P. formosanus* Kobayasi.

Phallus hadriani Vent. and *P. impudicus* L. var. *iosmos* (Berk.) Cooke have been reported from China (Mao 2000; Li et al. 2003). The authors have examined some specimens resembling *P. impudicus* but with a pinkish to purplish volva (e.g. MHSU 2155, labeled as "*P. hadriani*"). They are treated here as taxonomic synonyms of *P. impudicus* following Palmer (1968) and Liu (1984), because some collections possess both pinkish and non-pinkish volvae.

Phallus nanchangensis Z.Z. He is a red fungus with a rugulose pileus that is similar to *P. rubicundus* (He 1989), but it has a distinct rudimentary indusium under the pileus. The species was later transferred into *Dictyophora* based on the presence of the indusium, a critical character distinguishing *Dictyophora* from *Phallus* (Li et al. 2003):

Dictyophora nanchangensis (Z.Z. He) T.H. Li, B. Liu & B. Song, *Mycosystema* 22 (*Suppl.)*:44. 2003. **Figs. 5-6**

=*Phallus nanchangensis* Z. Z. He, *Acta Mycol. Sinica,* 8(2):98. 1989

Unexpanded *basidiome* globose to ovoid, white, reddish to pale red (9A1 to 9A3). Mature *basidiome* up to 8-20 cm high. *Receptacle* composed of a pileus and a stipe. *Pileus* conical to campanulate, 3.5-4 cm high and 1-2 cm broad, scarlet (9A8), discolouring to pale orange red or pastel red (7A4 or 8A4), rugulose, perforate at apex. *Gleba* on pileus surface dark greenish brown to olivaceous brown (3D6, 4D5 to 4E6), mucilaginous, foetid. *Stipe* cylindrical, up to 16-18 cm long, 1.5-2 cm thick, pale orange red or pastel red (8A4 to 9A5), usually paler than pileus, pink to whitish near the base, hollow, spongiose, wall composed of chambers which are partially open outwards. *Indusium* expanded to upper 1/3 portion of stipe or midway between pileus and volva, rudimentary, concolorous with pileus at first, then approaching stipe colour, membranaceous to slightly netted, fragile and evanescent when old. *Volva* white, reddish to pale red (9A1 to 9A3), 4-5 cm broad. *Basidiospores* cylindrical to long ellipsoid, 3.3-4 × 1.2-2 μm, light olivaceous, smooth.

Hab.: on the ground in a university campus and of the edges of a forest.

SPECIMENS EXAMINED—CHINA. **JIANGXI Province**: **Nanchan City,** JIANGXI UNIVERSITY—10 13 and 16.V.1987, *Z.Z.He and H.M.Luo 87011 (HKAS 18231), 87008 (HKAS 18230), HBDJU 87010*; **GUANGDONG Province:** DINGHUSHAN NATIONAL NATURE RESERVE—2. VI.1982, *Z. S. Bi and T.H. Li 6319* (HMIGD 6319).

This species is a rare endemic from south China, only reported from the Jiangxi and Guangdong Provinces. The red, narrow pileus is very unusual in *Dictyophora*, and the obvious (although rudimentary) indusium is not a feature of *Phallus*. It will possibly be a good intermediate taxon for studying the relationship between *Dictyophora* and *Phallus*.

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MYCOTAXON

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Some freshwater ascomycetes from Mexico

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Abstract—As part of a study of freshwater ascomycetes occurring on submerged *Pinus* sp. wood panels in two canals of Xochimilco, Mexico, *Ascotaiwania lignicola, Jahnula poonythii, Ophioceras commune* and *Savoryella lignicola* are reported from this country for the first time. Notes on the morphological characteristics of these species are given, including illustrations.

Key words—*Jahnulales,* lignicolous fungi, lotic habitats, *Magnaporthaceae, Sordariales*

Introduction

The biodiversity of fungi from Mexico remains unknown in large part. In this country there are probably 185 000 species of fungi, but only 6 710 have been recorded (Guzmán 1998). With reference to freshwater fungi, worldwide, around 511 species of ascomycetes and more than 500 species of hyphomycetes have been described (Cai et al. 2003, Goh & Tsui 2003). However, the diversity of Mexican freshwater mycobiota is little known with only two Chytridiomycota recorded by Céspedes and Castillo (1982), who registered *Rhizophydium keratinophilum* Karling from the State of Hidalgo, and *Allomyces neomoniliformis* Indoh from the State of Nuevo León. Unfortunately, those records cannot be verified because specimens were not preserved and deposited in a recognized collection, and the published records did not include illustrations. This is the first study on freshwater ascomycetes in this country and the results are preliminary. The Xochimilco ecological zone is located in the metropolitan region of Mexico City. This area has a network of navigable canals and waterways that surround raised areas called chinampas, on which flowers and vegetables have been grown since Aztec times (INEGI 2003). The Xochimilco region is an at risk ecosystem and, in 1987, UNESCO declared it a place of "Universal Human Patronage". Mexico City is on of the most populated cities of the of the most populated cities of the world and its water resources have considerable importance for its inhabitants. For this reason, we initiated a study of the freshwater ascomycobiota of metropolitan aquatic areas of the city. Results of this will contribute to the conservation and knowledge of important decomposers in freshwater habitats. The Xochimilco freshwater microscopic fungi have not been reported although they are basic components of this aquatic ecosystem. Four freshwater species of fungi are reported here as new for Mexico.

Materials and Methods

Wood panels (*Pinus* sp.) submerged for one month in the Santa Cruz Canal and 12 months in the Rombo Canal, both located near the Nativitas wharf, Xochimilco County, in South Mexico City, Federal District, Mexico (Figure 1), were placed in Zip-lock® plastic bags and transported to the laboratory in a cooler containing ice. Collected material was washed in tap water and placed in transparent plastic boxes containing moist paper towels (Jones 1971). Samples were incubated at laboratory temperature (25-30 C) under natural daylight supplemented by 12 h fluorescent light during the day. Wood panels from Santa Cruz Canal and Rombo were examined at 12 and 1 mo, respectively, for the presence of fungal fruiting structures. Squash mounts of ascomata in sterile water were prepared on glass slides, and ascomata, paraphyses, asci, and ascospores were measured and photographed using an Olympus BX50 light/interference/phase contrast microscope. For scanning electron microscopy, ascomata and ascospores were mounted onto a stub and air dried. The material was coated with gold palladium and examined in a Hitachi S-2460N scanning electron microscope operated at 20kv. The identified Ascomycetes were preserved *ex situ* in permanent microscope slides prepared according to the double cover glass method (Volkmann-Kohlmeyer & Kohlmeyer 1996), and also dehydrated on air dried wood panels. Specimens are deposited in the fungal collection of Herbario Nacional (MEXU) of the Institute of Biology in Mexico City, Mexico.

Taxonomy

Ascotaiwania lignicola Sivan. & HS Chang, Mycol Res 96: 481 (1992).

FIGURES 2-5

MATERIAL EXAMINED — MEXICO. Federal District: Xochimilco Co. Nativitas, Rombo Canal —5 Apr 2004 *MC González, A Chavarria MGFWR1* and slide nº 1 (MEXU 25134), *Pinus* sp. wood test block submerged 12 mo and incubated 1 mo.

Ascotaiwania lignicola is very similar to other multiseptate species, such as *A. mitriformis* and *A. wulai* in having 7-septate ascospores with hyaline end cells. However, *A. lignicola* has ascospores (42-55 × 8-13 μm) that differ in size, compared those of *A. mitriformis* (62.5-72.5 × 12.5-17.5 μm) and *A. wulai* (53-62 × 14-16 μm) (Sivanesan & Chang 1992; Ranghoo and Hyde 1998; Chang et al. 1998). The ascospore end cells in *A. mitriformis* are mitreshaped, whereas in the other species they are truncate (Ranghoo & Hyde 1998). The Mexican material has ascospores 37-40 × 7-10 μm, 7-septate and non mitriform, hyaline end cells. Although the ascospores of the Mexican specimen are narrower than those of *A. lignicola*, we determined that the Mexican fungus is this species and it is recorded for first time from Mexico.

Jahnula poonythii KD Hyde & SW Wong. Nova Hedwigia 68: 499 (1999).

FIGURES 8-16

MATERIAL EXAMINED — MEXICO. Federal District: Xochimilco Co. Nativitas, Rombo Canal —5 Apr 2004 *MC González, A Chavarria MGFWR2* and slide nº 2 (MEXU 25135), *Pinus* sp. wood test block submerged 12 mo and incubated 1 mo.

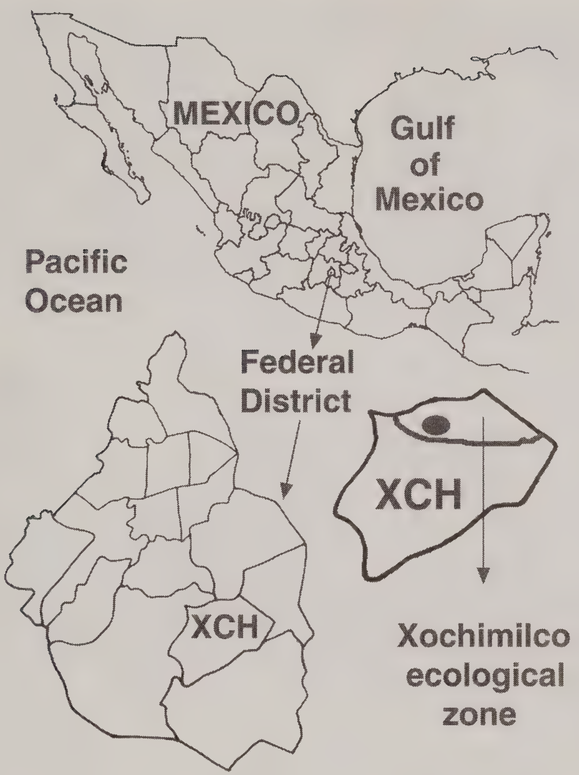
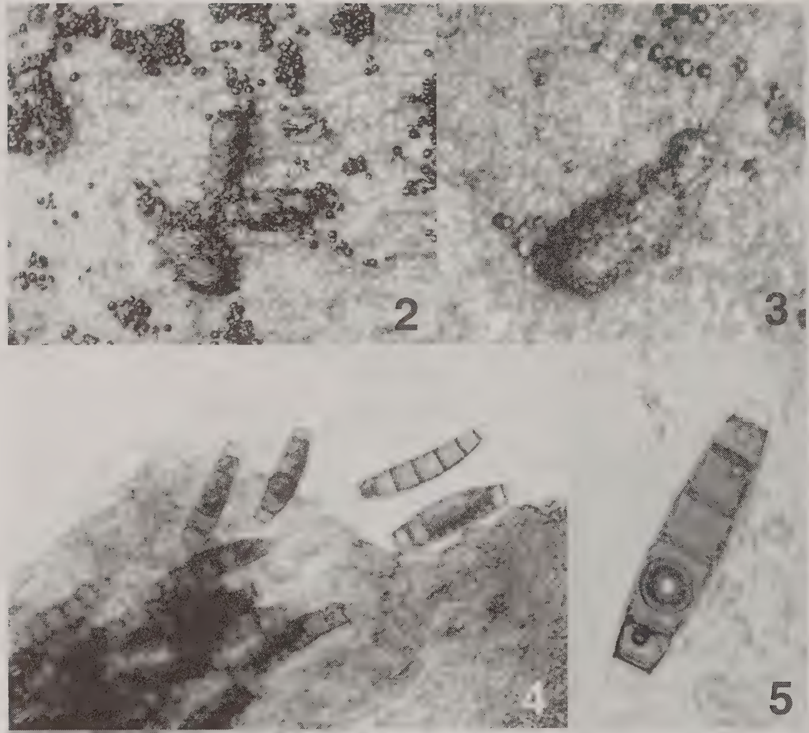
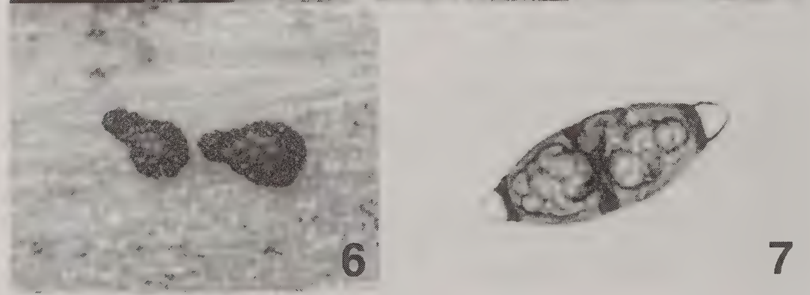


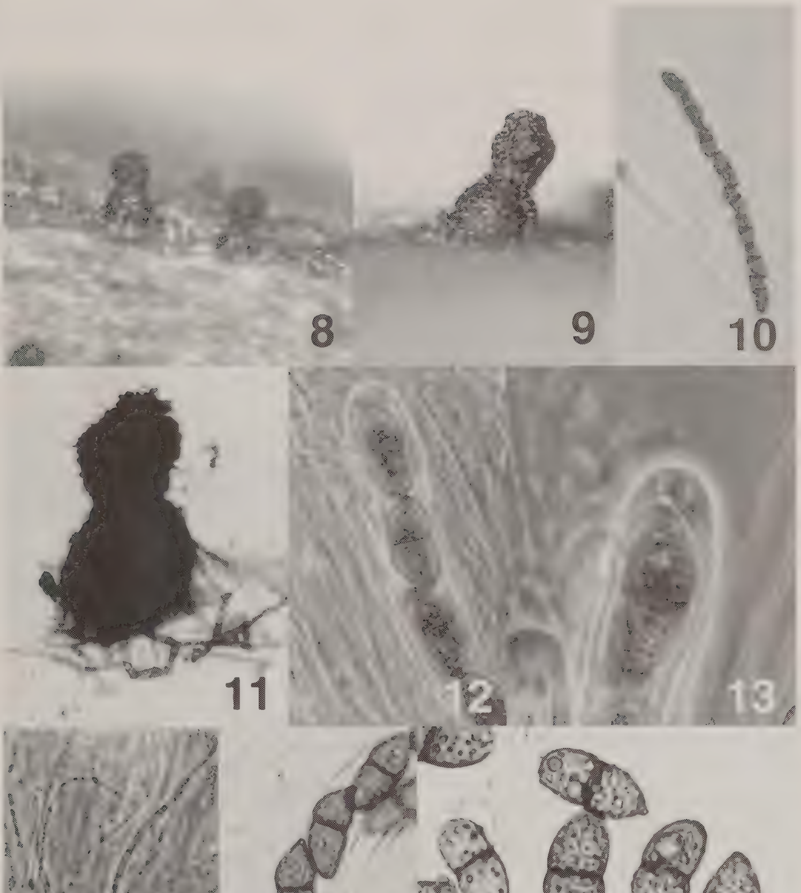
FIGURE 1 Map showing the Federal District, Xochimilco County (XCH) and the Xochimilco ecological zone location. The study area is represented by the black elliptical point in which freshwater Ascomycetes were recorded. Note that the Federal District is enclosed in the central part of the country and it is divided into 16 counties, one of which, XCH, is situated in the south.

The Mexican material has brown to dark brown ascomata, semi-immersed or erumpent, and becoming superficial with the base remaining immersed, membranous, ostiolate, papillate, with stalk-like strands attached to the base, solitary, subglobose, 350-500 μm diam; filiform pseudoparaphyses, persistent, septate, 1.5-2.5 μm wide; cylindrical asci, bitunicate, persistent, 8-spored, with apical ring, 175-212 × 14-18 μm; ellipsoid-fusiform ascospores, tapering to rounded apices, mostly uniseriate to overlapping uniseriate, 2-celled, strongly constricted at the septum, guttulate, 22-32 × 10-13 μm *Jahnula poonythii* has slightly smaller ascomata (350-420 μm diam) and ascospores (23-29 × 11-13 μm) and wider pseudoparaphyses (3 μm) (Hyde & Wong 1999; Pang et al. 2002). However, the Mexican collection is considered to be conspecific with *J. poonythii,* and is a new record for Mexico. Known distribution only from Mauritius (Hyde & Wong 1999).





FIGURES 2-5 *Ascotaiwania lignicola*. **2.** A cluster of ascomata horizontally oriented to the wood surface, ×46. **3.** Semi-immersed ascoma, ×90. **4.** Characteristic 7-septate ascospores with hyaline ends, ×675. **5.** Ascospore with non-mitriform hyaline end cells, ×1135. All photomicrographs taken with light microscopy. **FIGURES 6, 7**. *Savoryella lignicola*. **6.** Obpyriform superficial ascomata on substrate, ×53. **7.** Four-celled ascospore with central cells light brown and hyaline, smaller apical cells, ×1233. All photomicrographs taken with light microscopy.



FIGURES 8-16 *Jahnula poonythii*. **8, 9.** Subglobose ascomata releasing ascospores from the ostiole, ×20, ×38. **10.** Cylindrical 8-spored ascus, ×215. **11.** Ascomata with stalk-like strands attached to the base, ×50. **12, 13.** Bitunicate ascus with apical ring, ×300, ×770. **14.** Filiform persistent septate pseudoparaphyses ×400. **15, 16.** Ellipsoidal ascospores, slightly tapering towards the apices ×500, ×600. Photomicrographs taken with light microscopy 8, 9, 11, 16, differential interference contrast microscopy 10, 15, and phase contrast microscopy 12-14.

Ophioceras commune Shearer, JL Crane & W Chen. Mycologia 91: 146-149 (1999). FIGURES 17-25

MATERIAL EXAMINED — MEXICO. FEDERAL DISTRICT: **Xochimilco Co.** NATIVITAS, SANTA CRUZ CANAL —5 Apr 2004 *MC González, A Chavarria MGFWR3* and slide no 3 (MEXU 25136), *Pinus* sp. wood test block submerged 1 mo and incubated 12 mo.

Ophioceras commune is characterized by long necked ascomata, deciduous asci, and filiform, 3-7 septate, hyaline, 50-110 × 2 μm ascospores (Shearer et al.1999). The Mexican material has the same characteristics and agrees with the *O. commune* description, particularly, the ascospores are consistently 2 μm wide. This is a new record for Mexico. All the aquatic *Ophioceras* species have long necks and deciduous asci. Apparently the asci travel up the neck and out of the ostiole. In water, the ascospores are released by disintegration of the base of the ascus wall and are then be dispersed by water currents (Shearer et al. 1999). *Ophioceras commune* from Xochimilco exhibits the same characteristic. We have observed that a dense cluster composed of both intact and disintegrated asci mixed with groups of free ascospores is ejected from the ostiole, adhering to substrata with which it comes in contact (Figures 17-19). *Ophioceras commune* has been collected commonly in temperate areas of eastern North America (Shearer et al. 1999). Xochimilco is 2274 m above sea level and its climate is temperate (14-16 C).

Savoryella lignicola EBG Jones & Eaton. Trans Br mycol Soc 52: 162 (1969). FIGURES 6,7

MATERIAL EXAMINED — MEXICO. DISTRITO FEDERAL: **Xochimilco Co.** NATIVITAS, SANTA CRUZ CANAL— 5 Apr 2004 *MC González, A Chavarria MGFWR4* and slide nº 4 (MEXU 25137), *Pinus* sp. wood test block submerged 1 mo and incubated 12 mo.

Savoryella lignicola superficially looks like *S. limnetica*, but can be differentiated by its larger not markedly constricted ascospores (24-37 × 8-14 μm) (Hyde 1994; Chang *et al.* 1998). *Savoryella limnetica* has smaller less constricted ascospores (20.1-25.6 × 7-9 μm). The Mexican collection has ellipsoidal, 3-septate ascospores, not markedly constricted at the septa and pale brown central cells, 30-32 × 13-14 μm, cand is considered to belong to *S. lignicola*. Jones and Hyde (1992) found *S. lignicola* as a common and early coloniser of Scots pine test blocks in brackish water and growing superficially on the wood. The same was observed in the Mexican collection. *Savoryella lignicola* is known from marine, brackish water and freshwater environs with a worldwide distribution (Jones & Eaton 1969; Hyde & Jones 1988; Jones & Hyde 1992; Hyde 1993, 1994; Ho et al. 1997; Chang et al. 1998). Morphologically similar records of *S. lignicola* from diverse habitats may not be the same species (Hyde 1994; Ho et al. 1997). Therefore, more studies on morphology and distribution of this species as well as studies on the molecular level are necessary.

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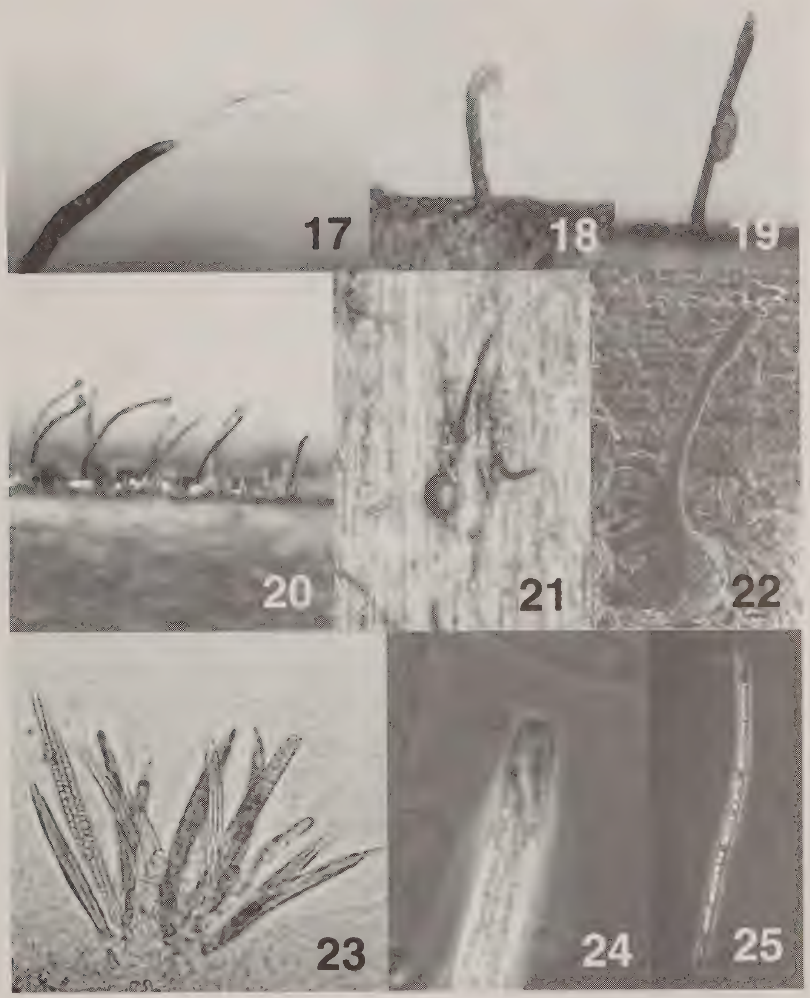

FIGURES 17-25 *Ophioceras commune*. **17-20.** Necks releasing ascospores from the ostiole, ×50, ×33, ×25, ×8. **21, 22.** Ascomata immersed to superficial, ×20, ×30. **23.** Asci and paraphyses, ×400. **24.** Ascus with apical apparatus, ×1000. **25.** Filiform ascospore, ×500 Photomicrographs taken with light microscopy 17-21, scanning electron microscopy 22, differential interference contrast microscopy 23, and phase contrast microscopy 24, 25.

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Hemimycena conidiogena, a new cistophilous basidiomycete

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Abstract - An ecological study of *Cistus* vegetation in Catalonia (Spain) revealed the existence of a previously undescribed species of *Hemimycena* section *Lacteae* characterized by a yellowish tinge on mature basidiomata and the production of blastoconidia on cap and stipe. This species, close to *H. lactea*, is described as *Hemimycena conidiogena*. Ecological distribution, taxonomical affinities, systematic position and nature of blastoconidia are discussed.

Résumé – Une étude écologique des cistaies en Catalogne (Espagne) a révélé l'existence d'une espèce inédite du genre *Hemimycena*, section *Lacteae*, caractérisée par la teinte jaunâtre des basidiomes mûrs et par la production de blastoconidies sur le chapeau et le pied. Cette espèce voisine de *H. lactea* est décrite ici sous le nom de *Hemimycena conidiogena*. La répartition écologique, les affinités taxinomiques, la position systématique et la nature des blastoconidies sont discutées.

Key words - Basidiomycetes, *Tricholomataceae, Hemimycena lactea*

Introduction

Since 1997, two of us (J. V. and X. Ll.) have been surveying the fungal community of the rockrose bush (*Cistus* spp.) associations in Catalonia. Based initially on several plots located in the Cap de Creus i Serra de Verdera Natural Park (NE of Catalonia), the fieldwork was extended to similar sites including Collserola Park (Barcelona) and Serra de Prades (SW Catalonia). The fungal community of the first area has been described by Vila & Llimona (1998, 1999, 2002).

In both reports, one *Hemimycena* species was reported under the name *H. candida* (Bres.) Singer. During the C.E.M.M. Congress (Girona, 2001), two of the authors (P.-A. M. and M. À. P.-De-G.) rejected this identification; further studies revealed a previously undescribed species with interesting and unusual microscopic features, described here as *Hemimycena conidiogena*. Dr M. Noordeloos was kind enough to check our observations and confirm the specificity of our taxon (cf Antonin & Noordeloos, 2004).

Methods

The first collections were made during the establishment of fungal records, following Darimont's (1975) methodology simplified as set forth in Vila & Llimona (1999). The collections were photographed, described, and dried. Tissues were rehydrated in 5% KOH and stained with Congo red; additional observations were made in Melzer's and Cotton blue. Cytological observations (nuclei staining) were made in acetic carmine from exsiccates.

Material studied

The examined collections are kept in the following herbaria: BCN-SCM and BCN-Myc (Centre de Documentació de Biodiversitat Vegetal, CERBIV, Parc Científic de Barcelona, Universitat de Barcelona), JVG (personal herbarium of Jordi Vila), PG (personal herbarium of Miquel À. Pérez-De-Gregorio), and LIP (Laboratoire de Botanique, Faculté des Sciences Pharmaceutiques et Biologiques, Université Lille II).

Taxonomy

Hemimycena conidiogena Vila, P.-A. Moreau & Pérez-De-Gregorio, *sp. nov.*
Fig. 1-11.

> *Pileus 5-15 mm in diam., hygrophanus, laevis, a transparentia striata pure candida deinde dilute ochraceo-lutescente. Laminae adnatae, pauce densae, relative crassae, candidae deinde lutescentes. Stipes teres, 15-25 × 1-2 mm, albescens, leviter lutescente, subtiliter pruinosus, basaliter pilosus. Caro pertenuis, albescens; odor et sapor inconspicui. Sporae (9)-10-12,5-(13) × 3,5-4,5-(5) µm, hyalinae, inamiloideae, non cyanophilae, anguste obovatae vel flexuosae, apice rotundatae, saepe conspiquam supraapicularem depressionem instructae. Basidia 22-30 × 6,5-8,5 µm, tetrasporata,, Lamellae acie fertilia, cum rara vel interdum frequentes cheilocystidia, 18-30 × 5,5-7 µm, fusiformes, apice manifeste capitulati, × 2,5-3,5 µm. Pleurocystidia desunt. Evaginationes ex breviter diverticulis aut pilis capitulatis usque ad 15-(20) µm longis ; blastoconidia libera rara, 6,5-11 × 3,5-6 µm. Stipitipellis ex pileipelle homologam, cum pilos capitulatos longiores, ad 25-(35) µm, et cum capitulos latiores, ad 8-9 µm, saepe in blastoconidiis transformatis. Fibulae in hymenio abundantes, rarae aut inconspicuae in aliis partibus basidiomatis. Holotypus prope vicum Roses dictum, in NE Catalonia (Hispania), a X. Llimona et J. Vila lectus, 23-1-2001, 95 m altitudinis, sub Cisto monspeliense et C. albide, in herb. BCN-SCM B 4063 conservatus.*
>
> *Etymology: conidium* = light dust, accessory spore, from the Greek κονις = dust; and *gena* = that produces, as feminine adjective.

Macroscopic description - **Pileus** 5-15 mm in diam., initially conic or conico-convex, at maturity more extended-flattened, usually not umbonate, hygrophanous, slightly depressed in some old basidiomata; margin straight; surface smooth, striate, initially pure white, later gradually more yellowish to ochraceous. **Gills** not crowded, 16-20 reaching the stipe, 1 (2) series of lamellules, convex, adnate, comparatively thick,

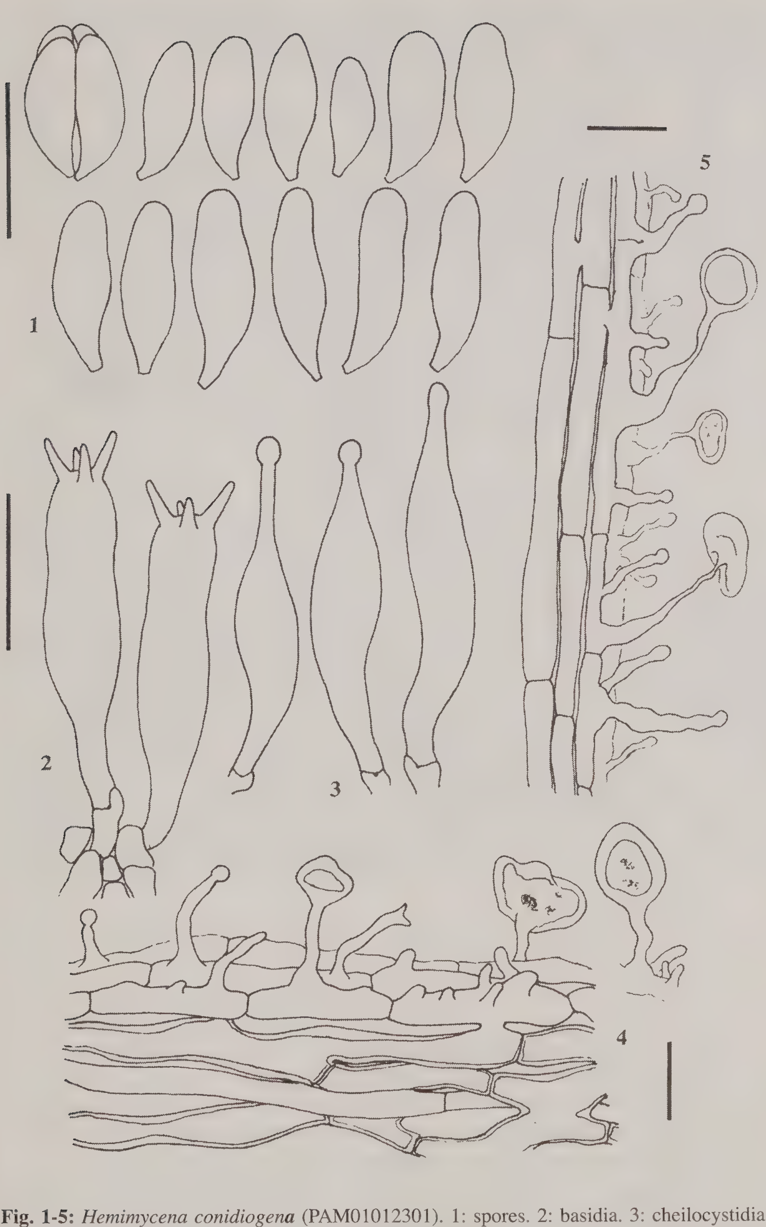


Fig. 1-5: *Hemimycena conidiogena* (PAM01012301). 1: spores. 2: basidia. 3: cheilocystidia. 4: pileipellis (radial cut) and detail of a blastosporal structure (right). 5: stipitipellis (radial cut).

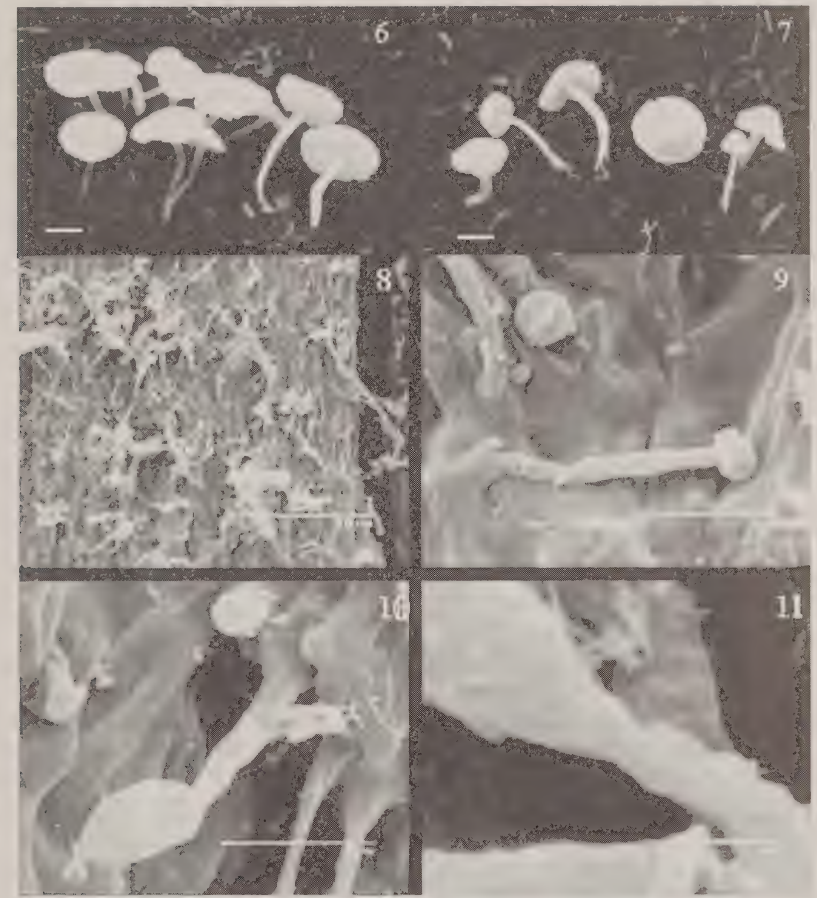
white, later yellowish or faint ochraceous; lamellulae present. **Stipe** 15-25 × 1-2 mm, cylindrical, whitish, later faintly yellowish, slightly translucent, at maturity with a thin pruina all over and basal hairs. **Flesh** very thin, whitish. Smell and taste not distinct.

Microscopic description (based mainly on exsiccates: *PAM01012301*, isotypus, and *PAM96012101*) - **Spores** (9)-10-12,5-(13) × 3,5-4,5-(5) μm, hyaline, not amyloid, not cyanophilic, with homogenous content (dry material), cylindrical with prominent apiculus to flexuous, with rounded apex, often wider in middle part and with often marked supraapicular depression. **Basidia** 22-30 × 6,5-8,5 μm, all 4-spored, clamped, cylindrical, often tapering forwards toward the apex; sterigmata straight, conical, 3,5-4,5 μm long. **Gill edge** fertile, with scarce to locally frequent cheilocystidia (leptocystidia), 18-30 × 5,5-7 μm, hardly protruding, fusiform with distinct capitulate apex × 2,5-3,5 μm on a more or less differentiated, slender neck. **Pleurocystidia** none. **Subhymenium** 10-15 μm thick, densely pseudoparenchymatous, with small elements × 2-5 μm, somewhat shortly ramose near hymenium. **Gill trama** almost regular, with slender hyphae × 3-4-(5) μm, somewhat branched. **Suprapellis** a cutis of 1-(2) layers of short, prostrate articles, 25-60 × 3-4 μm, scarcely to frequently budding with short filiform diverticules and capitulate hairs up to 15-(20) μm long, with rounded, widely cylindrical to somewhat globulous-misshapen head, some collapsing, with depressed apex. Free blastoconidia scarce, looking like aborted spores, thin- or not distinctly thick-walled, with small granulations inside, 6,5-11 × 3,5-6 μm. **Subpellis** 15-20 μm thick, poorly differentiated from the flesh, with parallel hyphae × 3,5-6 μm, with thin to irregularly thickened, yellowish wall. **Stipitipellis** homologous to pileipellis, with longer capitulate hairs up to 25-(35) μm, and heads wider up to 8-9 μm, often becoming misshapen, more or less lobate or collapsed blastoconidia up to 12 μm long. **Clamp connections** abundant in hymenium and subhymenium, rare or inconspicuous in other tissues. No part of basidioma dextrinoid or metachromatic in Cresyl blue. No gloeoplerous hyphae observed.

Cytology - The nuclear behaviour of *H. conidiogena* in basidia and spores is identical as that described by Valla (1967: 71). Spores contain usually 1 nucleus (sometimes 2); basidia contain 2-4 residual nuclei after spore ejection. Hyphae in subhymenium and basidioles are dicaryotic. Blastoconidia (attached) did not show distinct nuclei but a diffuse carminophilic content.

Ecological characterisation - *H. conidiogena* has been found only on litter of *Cistus monspeliensis*, in the bush association *Cisto-Sarothamnetum catalaunici* O. de Bolòs 1956 sub association *cistetosum monspeliensis* Lapraz 1976. It belongs to the group of fungal species characteristic of the coenomycia *Russulo monspeliensi-Rectipilecium cistophili*, typified in Vila & Llimona (1999). Other species found sharing the same ecology are: *Agaricus porphyrizon, Clitocybe cistophila, Clitopilus scyphoides f. omphaliformis, Collybia catalaunica, C. dryophila, C. graveolens, C. inusitata, Crinipellis stipitaria, Flammulaster carpophilus, Lepiota clypeolaria, Leucoagaricus melanotrichus, Rectipilus cistophilus, Thelephora caryophyllea.*

Recent unpublished records have given a more precise idea of its ecology, as one of the saprobe species that colonize *Cistus monspeliensis* litter in winter, when a short



Figs. 6-11. *Hemimycena conidiogena.* **Figs. 6–7:** Sporophores *in situ*. Photo by J. Vila (bar = 1 cm). **Fig. 8–11:** Modified hairs producing blastoconidia (stipitipellis). SEM photos by J. Llistosella.

series of days free of desiccating wind enable the abundant dead leaves to conserve the humidity of December or January rainfall and dew.

SPECIMENS EXAMINED - SPAIN - BARCELONA: Can Ferrer, Serra de Collserola, Barcelona (Barcelonès), UTM 31T 4294588, alt. 240 m under *Cistus monspeliensis*, 23-10-2000, leg. X. Llimona and J. Vila, *BCN-Myc*.- Ibid., 25-1-2001, leg. X. Llimona and J. Vila, *JVG 1010125-1*. **GIRONA**: Near Sant Pere de Rodes, El Port de la Selva (Alt Empordà), UTM 31T 5144686, alt. 470 m, under *C. monspeliensis* and *C. albidus*, 4-12-1999, leg. O. Llimona and X. Llimona, *BCN-Myc*.- Ibid., 22-4-2000, leg. O. Llimona and X. Llimona, *BCN-Myc*.- Coll de la Perafita, Roses (Alt Empordà), UTM 31T 5194682, alt. 250 m, under *C. monspeliensis*, 9-12-2000, leg. X. Llimona and O.

Llimona, *BCN-Myc*.- Can Marés, Roses (Alt Empordà), UTM 31T 5174677, alt. 130 m, under *C. monspeliensis*, 28-11-2000, leg. X. Llimona, J. Vila, L. Muñoz, L. Peiró and M. Conejero, *JVG 1001128-30*.- Collet sobre la Falconera, Roses (Alt Empordà), UTM 31T 5174676, alt. 95 m, under *C. monspeliensis* and *C. albidus*, 23-1-2001, leg. X. Llimona and J. Vila, *BCN-SCM B 4063* (**Holotypus**), *JVG 1010123-20* (**Isotypus**), and *PAM 01012301* (**Isotypus**, LIP).- *Ibid*., 22-2-2001, leg. X. Llimona, J. Vila, L. Muñoz, C. Gutiérrez and M. Conejero, *BCN-Myc*.- Along the way to Sant Quirze de Colera, Rabós (Alt Empordà), UTM 31T 50469, alt. 160 m, under *C. monspeliensis*, 21-1-1996, leg. M.À. Pérez-De-Gregorio, *PG960121*, and PAM n° *96012101, LIP*.

Discussion

Systematic position - White species of *Mycena* (Pers.) Roussel or *Hemimycena* Singer with non-dextrinoid flesh have not been covered in monographs since the revisions of Kühner (1938), Smith (1947), and Valla (1969). Although Kühner (*op. cit.*: 538), Smith (*op. cit.*: 149) and again Kühner (1980: 729) pointed out the close affinities between their sections *Adonidae* (Fr.) Quél. and *Lacteae* in a wide sense of *Mycena*, most contemporary authors follow Singer's (1986) classification, placing the second section in the genus *Hemimycena*. Maas Geesteranus (1990) also points out close affinities between *Mycena* and *Hemimycena* and the transient position of *Mycena flavoalba*. Because we believe that a generic separation between both groups of species is possible, we have chosen to follow Singer's classification. Antonín & Noordeloos (2004) agree with this position.

Within this group of white species, *H. conidiogena* is characterized by the yellowish tinge of the mature basidiomata (an exceptional feature in *Hemimycena*), by its elongated spores, and also by its preferentially cisticolous habitat, strongly selective for *Cistus monspeliensis*. But the most unusual characteristic is the presence of "hairs" generating blastoconidia on pileus and stipe (*inde nomen*), showing analogies with those of *H. lactea*.

Presence of hairs on surfaces excludes the possibility of a species allied to *Hemimycena* sect. *Candidae*: *H. candida* (Bres.) Singer (Kühner 1938) and *H. ochrogaleata* (J. Favre) Singer (Favre 1955; Lamoure 1973-1974; Breitenbach & Kränzlin 1991), both with deeply decurrent gills. In keys including *Mycena* and allied genera (Kühner 1938; Smith 1947; Kühner & Romagnesi 1953; Moser 1978; Maas Geesteranus 1990), *H. conidiogena* may key out both as *Mycena* sect. *Adonidae* or *Hemimycena* sect. *Lacteae*, according to the importance given to colour of basidiomata. Moreover, *H. conidiogena* reminds strongly of *Mycena flavoalba* in fresh as well as in dry condition. The classification of such a coloured species within *Hemimycena* is justified by a comparative analysis of unamyloid-spored taxa in both genera (**Tab. 1**).

Except for the general colours of basidiomata, all characters of *H. conidiogena* match *Hemimycena* definition. As mentioned in our description, the yellow pigment is localized in hyphal wall. Consequently, the colour appears here as a derived character, not homologous to the vacuolar pigmentation of *Adonidae* (especially *M. flavoalba;* Kühner 1938). Pigment localization of another critical species with ochraceous colours, *H. ochrogaleata*, is still unclear (Lamoure 1973-1974: 57) but might also be parietal.

Because of this combination of features, *H. conidiogena* belongs unambiguously to *Hemimycena* sect. *Lacteae*, and the comparative analysis with *H. lactea* suggests a close relationship between both species.

Table 1. Determinant characters between *Mycena* sect. *Adonidae* and *Hemimycena* sect. *Lacteae* (data from Kühner 1938; Smith 1947; Maas Geesteranus 1990).

	Mycena* sect. *Adonidae	***Hemimycena* sect. *Lacteae***	***H. conidiogena***
Common characters	Spores not amyloid Subpellis not pseudoparenchymatous Cheilocystidia numerous, often bearing mucilage Hair-like caulocystidia present		
Colour of basidiomata	Pale yellow, orange to bright pink (vacuolar pigment)	Pure white	Yellowish cream
Dextrinoidity (Melzer's reagent)	Negative to positive (Kühner 1938)	Negative	Negative
Metachromatic coloration (Cresyl blue)	Positive	Negative	Negative
Pileal structure	Brush-like, sometimes with hairs	Hairs frequent, brush-like structures variable	Hairs abundant, brush-like structure poorly developed.

Comparison with other species of *Hemimycena* - Although many species of *Hemimycena* have been described during the XXth century (especially Kühner 1938, Smith 1947, Orton 1960, Kühner & Valla 1972, Malençon & Bertault 1975, Redhead 1982, Singer 1986, Romagnesi 1992, etc.), *Hemimycena* sect. *Lacteae* has remained a paucispecific section, including several cosmopolitan and common species (*H. cucullata, H. lactea, H. pseudolactea*) and several infrequent or less known taxa (*H. delicatella, H. rickenii, H. gypsella*). Macroscopically, *H. conidiogena* does not resemble any of these species, which are all pure white or, at the most, whitish.

The peculiar spore shape observed in *H. conidiogena* is the same as described and illustrated by Kühner (*loc. cit.*) for "*Mycena lactea*" (fig. 233) and "*M. pseudolactea*" (fig. 226) and by Smith for "*M. gypsea*" (*loc. cit.*, fig. 13 (3), "*M. pseudolactea*" (fig. 15 (2)) and "*M. delicatella*" (fig. 15 (3). The typical slender-capitulate, almost lecithiform shape of cheilocystidia is also present in *H. lactea* (Kühner, *loc. cit.*, as irregularly distributed) and in *H. delicatella* (Smith 1947: 163, as abundant - there are also pleurocystidia).

H. delicatella (Peck) Singer has been verified only from North America (Smith 1947: 161) and Japan (Hongo 1954), with clavate to cylindrical cheilocystidia and small spores (7,5-9,5 × 2,5-3,5 μm) ; Smith (1947: 163) and Maas Geesteranus (1980: 409) make it a synonym of *H. lactea* ss. Kühner.

H. lactea (Pers.: Fr.) Singer, in its four-spored form (Kühner 1938; Valla 1969; Kühner & Valla 1972 ; Malençon & Bertault 1975), shows fusiform cheilocystidia with slender neck and capitulate apex and hair-like elements in pileipellis. Because of these last morphological features, *H. lactea* is obviously the closest relative of *H. conidiogena*.

The spores of *H. conidiogena* are longer (10-12,5 × 3,5-4,5 μm) than in those mentioned species. The main differences between *H. lactea* (four-spored form) and *H. conidiogena* are summarized in **Tab. 2**.

Table 2. Comparison between *Hemimycena lactea* (4-spored forma) and *H. conidiogena*

	Hemimycena lactea	***Hemimycena conidiogena***
Cap	1-1,5 (2) cm, pure white, remaining so, sulcate.	0,5-1,5 cm, pure white, then yellowish-ochraceous, sulcate.
Stem	0,5-1 mm diam., hyaline white, pruinose.	1-2 mm diam., whitish, then faintly yellowish, finely pruinose.
Spores	(6,5) 7-10 (11,5) × (2) 2,5-3 (3,5) μm.	(9) 10-12,5 (13) × 3,5-4,5 (5) μm.
Basidia	23-27 × 5,5-6 μm, 4-spored.	22-30 × 6,5-8,5 μm, 4-spored.
Suprapellis	A cutis with abundant, thin, erect, non-capitate hairs.	A cutis with scarce to locally numerous short capitate hairs ("conidiophores").
Stipitipellis	A cutis with numerous, irregular, filiform to capitulate hairs.	A cutis with rather numerous capitate hairs (some modified in "conidiophores").
Flesh	Hyphae with hyaline, thin walls (< 0,5 μm).	Hyphae with yellowish thickened walls, up to 1 (1,5) μm thick.
Ecology	Coniferous litter	*Cistus* spp. litter.

Valla (1969) compares these formations to those observed on mycelium of *Clitocybe senilis* (Fr.) Gillet, and to the "acremoniform branches" described from *Psilocybe* cultures. Recently Norvell (1998) also reported similar structures as "tibiiform diverticula" on the mycelium of *Phaeocollybia* spp., and suggested an excretive (protective) function for them, as shown on a few dark-spored Agarics (Hutchinson et al., 1996).

In fact, since De Bary (1859) described chlamydospores in *Asterophora lycoperdoides* Sow.: Fr., mitospores have rarely been described from basidiomata of Agarics; most of them have been identified from mycelium cultures (Vandendries, 1937; Oddoux 1957; Watling 1979; Stalpers 1987).

Clémençon (1997: 286) distinguishes three kinds of mitospores in Hymenomycetes: arthroconidia (from hyphal fragmentation), chlamydospores (differentiated with thick walls) and blastic mitospores (differentiated with thin walls). Following this classification, mitospores of *Hemimycena* should be classified as blastic mitospores, more precisely as blastoconidia (introduced by Stalpers, *op. cit.*, for *Galzinia*). Clémençon (*op. cit.*: 334) reports analogue formations as sympoduloconidia.

Up to now, blastoconidia are only reported in one agaric: *Baeospora myosura* (Fr.) Singer, from mycelial cultures (Kendrick & Watling 1979; Clémençon, *op. cit.*: 287). All mitosporic formations compared by Valla (1969) to those of *H. lactea* can be considered as arthroconidia according to these recent classifications. In Watling's conspectus (1979), these formations would be called "blastic conidia", and compared to mycelial conidia illustrated from *Hohenbuehelia* (*loc. cit.*: 457, fig. 19.1 O). Because of the analogies with *Baeospora* conidia, we have chosen to report them as "blastoconidia". Cultures and more efficient research of nuclear material in these conidia will be necessary to interpret thoroughly these structures.

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Two Hyphomycetes from submerged plant material of México

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Abstract—*Neta mexicana* anam. sp. nov. distinguished by vermiform, unicellular, hyaline conidia and *Idriella cagnizarii*, both found on decaying leaves of an unidentified plant submerged in a stream, are described and illustrated.

Key words—Aquatic fungi, systematics, tropical fungi

Introduction

More than 33 hyphomycetes were collected during mycological surveys of conidial fungi from submerged plant material in an undisturbed rainforest of Los Tuxtlas (Veracruz, Mexico). Among the collections was a conspicuous fungus clearly related to the genus *Neta* Shearer & J. L. Crane (Shearer & Crane 1971); it is described as new to science. Furthermore, *Idriella cagnizarii* R. F. Castañeda & W. B. Kendr. (Castañeda & Kendrick 1991) is recorded from Mexico for the first time.

Neta comprises species with hologenous, multilocal, sympodially proliferating, integrated, indeterminate conidiogenous cells with long protuberant conidiogenous loci and schizolytic conidial secession. Their conidia are solitary, hyaline, aseptate or with up to several septa and variable in shape (Castañeda & Heredia 2000). *Neta* includes nine terrestrial and aquatic species: *N. patuxentica* Shearer & J. L. Crane (Schearer & Crane 1971; the type species), *N. lignicola* Shearer (Shearer 1974), *N. quadriguttata* (Matsush.) de Hoog (De Hoog 1985a), *N. compacta* de Hoog (De Hoog 1985b), *N. salmonicolor* (Shearer) de Hoog (De Hoog 1985a), *N. gibbosospora* R. F. Castañeda & W. B. Kendr. (1990), *N. angliae* K. D. Hyde & Goh (Hyde & Goh 1999), *N. gigaspora* R. F. Castañeda & Heredia (Castañeda & Kendrick 2000), and *N. tropicalis* R. F. Castañeda, Guarro & Géne (Castañeda et al. 2000). The *Neta* synanamorphs of *Ramichloridium ovoideum* (Matsush.) de Hoog and *Cladosporium bisporum* Matsush. were briefly discussed by Castañeda & Heredia (2000).

Taxonomy

Neta mexicana R. F. Castañeda, Heredia et R. Arias anam. sp. nov.

FIGURES 1-2a

> *Ad fungos conidiales, hyphomycetes pertinens. Coloniae in substrato naturali funiculosae, albae. Mycelium plerumque superficiale, ex hyphis septatis, ramosis, levibus, hyalinis vel subhyalinis, 1.0-1.5 µm diam., compositum. Conidiophora inconspicua, in cellula conidiogena reducta. Cellulae conidiogenae multiloculosae, sympodiales, indeterminatae, hyalinae, 4-15 x 1.5 µm. Loci conidiogeni denticulati. Secedentia conidiorum schizolytica. Conidia vermicularia, solitaria, truncata ad basim, rotundata vel obtusa ad apicem, unicellularia, hyalina, levia, 13-16 x 5.0-6.5 µm. Teleomorphosis ignota.*
>
> ***Etymology***: In reference to México.

Conidial fungi, hyphomycetes. **Colonies** on the natural substratum funiculose, white. Mycelium mostly superficial. Hyphae septate, branched, smooth-walled, hyaline, 1.0-1.5 µm diam. **Conidiophores** undifferentiated, reduced to conidiogenous cells. **Conidiogenous cells** hologenous, multilocal, indeterminate, sympodial, cylindrical, hyaline, 4-15 x 1.5 µm, arising from the vegetative hyphae. **Conidiogenous loci** denticulate with conspicuous, 2-3 µm long denticles. **Conidial secession** schizolytic. **Conidia** vermiform, solitary, one-celled, acrogenous, truncate at the base, rounded to obtuse towards the apex, hyaline, smooth-walled, 13-16 x 5.0-6.5 µm. **Teleomorph**: unknown. **Matrix:** on decaying leaves submerged in a stream, in the rainforest "Los Tuxtlas", Veracruz, México, coll. R. M. Arias, J. Yadeneiro de la Cruz Elizondo & R. F. Castañeda, 19. V. 2002 (**Holotype**- MUCL 45626).

COMMENTS: Among the previously described *Neta* spp. keyed out by Castañeda & Heredia (2000), the new species superficially resembles *N. gibbosospora*, which has unicellular, gibbous conidia that are 4-7 x 1.5-2.5 µm.

Also recorded from submerged plant material in Mexico:

Idriella cagnizarii R. F. Castañeda & W. B. Kendr., *Univ. Waterloo Biol. Ser.* **35:** 63 (1991).

FIGURE 2b

Colonies on the natural substrate effuse, white at first, later yellow, amphigenous, sometimes forming scattered, compact, 70-120 µm diam., pulvinate sporodochia.

Mycelium mostly immersed. **Conidiophores** differentiated, mononematous, erect or prostrate, usually branched, sometimes unbranched, cylindrical, brown at the base,subhyaline towards the apex, up to 45 μm long. **Conidiogenous cells** multilocal, hologenous, sympodial, discrete, subhyaline, 5-22 x 3-4 μm. **Conidia** cylindrical to fusiform, curved at the ends, uniseptate, smooth- and thin-walled, hyaline, always of two sizes, 10-15 x 2 μm or 20-26 x 2 μm. Usually with many narrow, colorless crystals protruding from the conidiogenous cells and mixed with conidia in a compact cluster.

Material examined C02/19, on decaying leaves submerged in a stream, in the rainforest “Los Tuxtlas”, Veracruz, México, coll. R.M. Arias, J. Yadeneiro de la Cruz Elizondo & R.F. Castañeda, 19. V. 2002. Distribution- Brazil, Cuba, Venezuela.

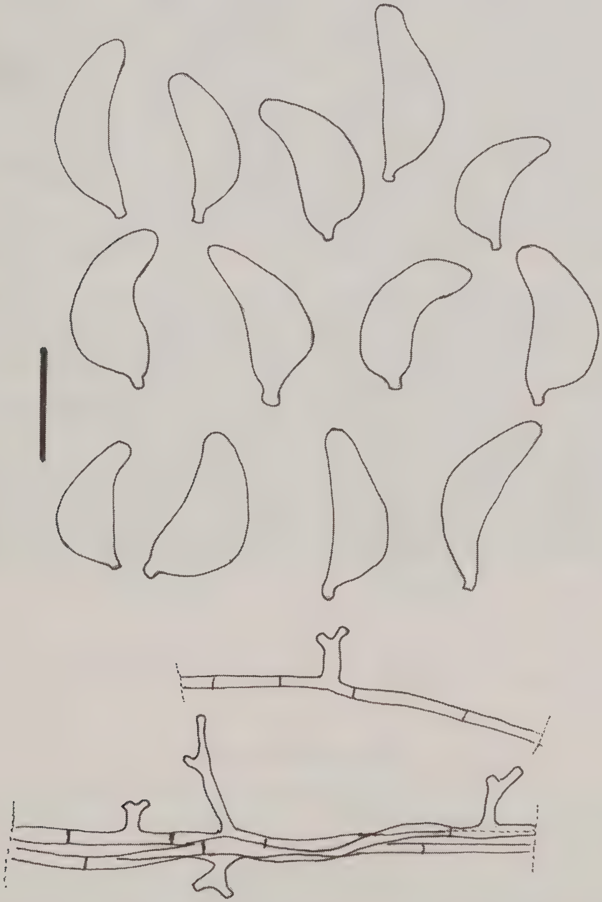

Fig. 1. *Neta mexicana.* Drawing of conidiogenous cells and conidia. Bar 10 μm.

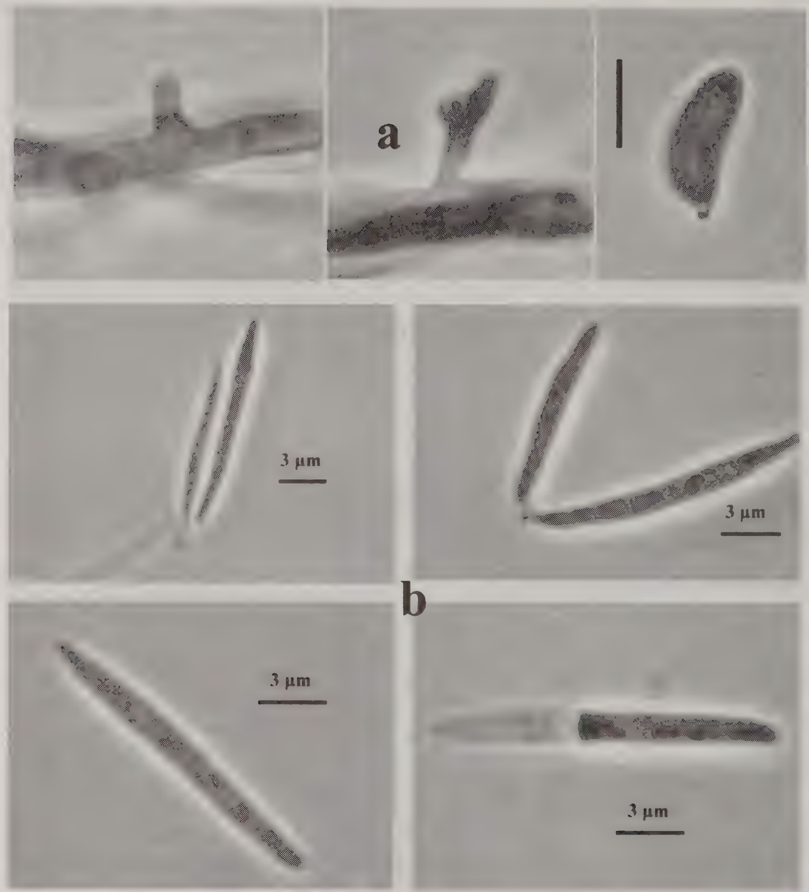

Fig. 2a: *Neta mexicana*. Micrographs of conidiogenous cells and conidia. Bar 10 μm.
Fig. 2b. *Idriella cagnizarii*. Conidiogenous cells and conidia. Scale is indicated by bars.

COMMENTS: *Idriella cagnizarii* has been collected from leaf litter in several rainforests (Castañeda et al. 2003), but this is the first report of the fungus from an aquatic habitat.

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We are deeply indebted to Profs. Lori M. Carris (Washington State University) and Uwe Braun (Martin-Luther-Universität Halle-Wittenberg, Germany) for kindly reviewing the manuscript and for many suggestions that greatly improved it. Furthermore, it is our pleasure to thank the Cuban Ministry of Agriculture and CITMA for facilities through projects 2053, 2053 and 2054, and the CYTED for financial support through the "Red Iberoamericana sobre Diversidad, Ecología y Uso de los Hongos (REDEMIC, México).

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MYCOTAXON

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Microfungi from submerged plant material: *Zelotriadelphia amoena* gen. et sp. nov. and *Vanakripa fasciata* sp. nov.

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Abstract— *Zelotriadelphia amoena* anam. gen. et sp. nov. and *Vanakripa fasciata* sp. nov. found on decaying leaves of *Terminalia cattapa* and wood submerged in a river, are described and illustrated. The former is distinguished by hologenous, unilocal, determinate or indeterminate conidiogenous cells, and broadly obovate, 1-distoseptate, very pale brown to olive-brown conidia and the latter is characterized by unicellular, elliptical, brown conidia with a central dark brown to black band. A key to *Vanakripa* species is provided.

Key words— aquatic fungi, systematics, tropical fungi

Introduction

During two independent expeditions (1997, 2002) an interesting hyphomycete was collected in 1997 on submerged decaying leaves of *Terminalia cattapa* in San Antonio, Habana province, Cuba and in 2002 on a submerged decaying leaf of unidentified *Myrtaceae* in a river, in "Colonia Tovar," Estado Aragua, Venezuela, It showed remarkable differences from previously described hyphomycetes and is therefore described as a new genus and species. Also during the investigation on freshwater microfungi on a sample of submerged wood an interesting conidial fungus clearly related to *Vanakripa* was collected. It is described below as *Vanakripa fasciata* sp. nov.

Taxonomy

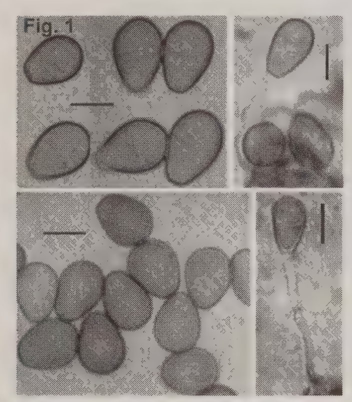
Zelotriadelphia R. F. Castañeda, Saikawa, M. Stadler et Iturr., anam. gen. nov.

> *Ad fungos conidiales, hyphomycetes pertinens. Coloniae effusae, brunneae usque olivaceae. Mycelium partim superficiale et partim in substrato immersum. Conidiomata sporodochia, dissita, brunnea, olivacea vel nigra. Conidiophora inconspicua, septata, hyalina usque ad dilute brunnea, plerumque in cellula conidiogena reducta. Cellulae conidiogenae uniloculosae, hologenosae, determinatae, sed interdum indeterminatae cum proliferationibus holoblasticis sympodialis et enteroblasticis percurrentis. Loci conidiogeni apicali, complanatis, raro lateralibus,. Secedentia conidiorum schizolytica. Conidia solitaria, acrogena, distoseptata, obovata, globosa, pyriformia, brunnea, olivacea usque ad nigra, levia vel verrucosa. Teleomorphosis ignota.*
>
> Etymology: Greek, *Zelo-*, meaning emulation, *Triadelphia*, a genus of hyphomycetes.

Conidial fungi, hyphomycetes. **Colonies** effuse, brown to olivaceous. Mycelium superficial and immersed. **Conidiomata** sporodochial, scattered, brown, olivaceous or black. **Conidiophores** undifferentiated, septate, hyaline to pale brown; frequently reduced to conidiogenous cells. **Conidiogenous cells** unilocal, hologenous, determinate, but sometimes indeterminate with holoblastic sympodial proliferations and enteroblastic percurrent proliferations. **Conidiogenous loci** apical, flatted, rarely lateral. **Conidial secession** schizolytic. **Conidia** solitary, acrogenous, distoseptate, obovate, globose, pyriform, brown, olivaceous to black, smooth-walled or verrucose. Teleomorph: unknown.

COMMENTS: The genus *Zelotriadelphia* is somewhat similar to *Triadelphia* Shearer & J.L. Crane (1971) [Constantinescu & Samson 1982, Kirk 1983, Sutton 1989] in the hologenous, unilocal conidiogenous cells and solitary, pigmented conidia, but no percurrent proliferations are present in the pleomorphic genus *Triadelphia* and the conidia are usually polymorphic (2-5 forms) and euseptate, often with black bands at the septa and sometimes with an excentrically situated transverse septum near the base as exemplified by *T. uniseptata* P.M. Kirk (1983) and *T. australiensis* B.C. Sutton (1989). In *Zelotriadelphia* polymorphic and euseptate conidia are absent. The genera *Spilocaea* Fries (Ellis 1971), recently reduced to synonymy with *Fusicladium* Bonord. emend. by Schubert et al. (2003), and *Oedothea* Sydow (Ellis 1971) appear superficially similar to *Zelotriadelphia*; these genera all have hologenous, unilocal, percurrently proliferating conidiogenous cells and solitary conidia, but the species described in these genera all have superficial or immersed, erumpent, pseudoparenchymatous stromata, and their conidia are euseptate.

The genus *Stigmina* Sacc. (Ellis, 1971, 1976) is closely related to *Zelotriadelphia*, but the generic concept of *Stigmina* was restricted to foliicolous species consistently associated with stomata and conidia solitary, holoblastic, distoseptate, brown typically being formed from percurrently proliferating, verruculose, ragged conidiogenous cells by Sutton and Pascoe (1989). These workers commented that "conidial secession is schizolytic but the separation of both the outer and inner wall layers is not synchronised as in most related fungi. Hence, the outer wall layers break first and many conidia are observed attached only by the inner wall. As a result conidia are seen with a ridge or frill of the outer wall material." Accordingly, *Zelotriadelphia* differs in its conidiomata not



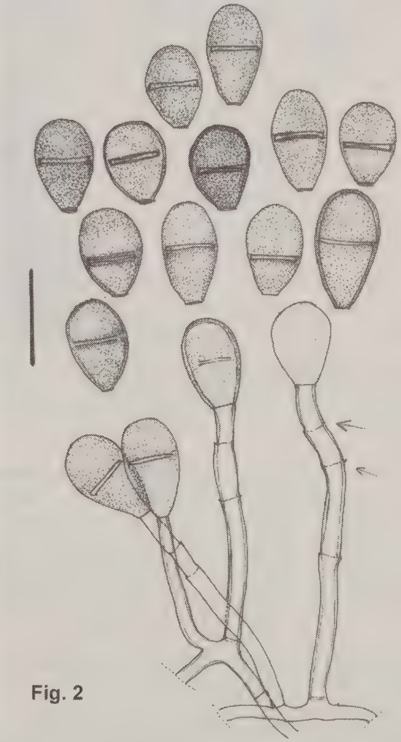
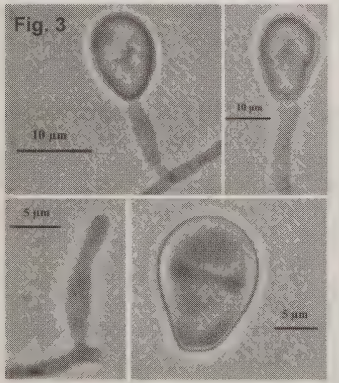


Fig. 2



Figs. 1-3: *Zelotriadelphia amoena*. Bars = 10 µm. **Figs. 1–2.** Ex holotype culture MUCL 44638. Photomicrographs of conidiophores, conidiogenous cells and conidia. **Fig. 2**: Drawings of Conidiophores, conidiogenous cells and conidia. Annellations of conidiogenous cells are indicated by arrows. **Fig. 3** Ex culture INIFAT C02/6. Photomicrographs of conidiogenous cells and conidia.

being suprastomatal and in not producing pseudoparenchymatous stromata. Moreover, in the new genus, conidiogenous cells are not ragged; the separation of the outer and inner wall layers occurs simultaneously as in most conidial fungi, and conidia are thus easily detached.

Zelotriadelphia amoena R.F. Castañeda, Saikawa, M. Stadler et Iturr. anam. sp. nov. **FIGURES 1-3**

Coloniae in substrato naturali effusae, amphigenae, maculiformes, olivaceae usque ad brunneae. Conidiomata sporodochia, dissita, angulosa vel irregularia, 200-2600 µm longa, 130 -1540 µm lata, compacta. Mycelium partim superficiale et partim in substrato immersum, ex hyphis septatis, perramosis, 1-3 µm diam., laevibus, dilute brunneis compositum. Conidiophora inconspicua, mononematosa, dilute brunnea vel subhyalina, in cellula conidiogena reducta. Cellulae conidiogenae determinatae, cylindricae, leviter ampliatae ad apicem, 8-13 x 3.0-3.5 µm, laeves, subhyalinae. Loci conidiogeni apicalis, complanatis. Conidia obovata, truncata ad basim, non septata ad 1-distoseptata, 9-12 (-18) x 8-11 µm, levia, brunneo-olivacea usque ad brunnea. Teleomorphosis ignota.

Etymology: Latin, *amoenus*, meaning pleasant, agreeable.

Colonies on the natural substratum effuse, amphigenous, spot-shaped, olivaceous to brown. **Conidiomata** sporodochial, scattered, angular to irregular, 200-2600 µm long, 130 -1540 µm wide, compact. Mycelium superficial and immersed, septate, branched, 1-3 µm diam., smooth-walled, pale brown hyphae. **Conidiophores** undifferentiated, mononematous, very pale brown or subhyaline, mostly reduced to conidiogenous cells. **Conidiogenous cells** unilocular, hologenous, determinate, cylindrical, slightly enlarged towards the apex, 8-13 x 3.0-3.5 µm, smooth-walled, subhyaline. **Conidiogenous loci** apical, flattened. **Conidial secession** schizolytic. **Conidia** solitary, acrogenous, obovate, truncate at the base, aseptate to 1-distoseptate, 9-12 (-18) x 8-11 µm, smooth-walled, brown-olivaceous or brown. **Teleomorph** unknown.

TYPUS: **CUBA. Habana:** San Antonio de Los Baños, on decaying leaves of *Terminalia cattapa* Linn. submerged in a river, in undisturbed rainforest, 01.II.2002, leg. R. F. Castañeda Ruiz (**MUCL 45631**-HOLOTYPUS; **INIFAT C02/10**-ISOTYPUS), culture MUCL 45631.

ADDITIONAL MATERIALS EXAMINED: CUBA. Habana: San Antonio de Los Baños, on decaying leaves of Terminalia cattapa Linn. submerged in a river, 14.VII.1997, leg. R. F. Castañeda Ruiz & M. Saikawa (**INIFAT C97/ 201**) - **Habana:** San Antonio de Los Baños, on decaying leaves of Terminalia cattapa Linn. submerged in a river, in undisturbed rainforest, 02.II.2002, leg. R. F. Castañeda Ruiz (**INIFAT C02/10**) – **Venezuela:** forest near Colonia Tovar, Estado Aragua, on submerged decaying leaves of unidentified Myrtaceae in a river, Dec. 16, 2003, leg. Julian Mostacero. (**USB C03/46**).

Colonies on corn meal agar (Difco) mixed 1:1 with carrot extract at 25 °C under alternating cycles of 12 hours of daylight and darkness attaining 19-26 mm in 7 days, gray-brown, floccose, with regular margin. Hyphae very pale brown to subhyaline, smooth-walled, 1.5-2.5 µm diam. Conidiophores differentiated, mononematous, erect, simple or branched, cylindrical, 10-35 x 2.-3.5 µm, septate, smooth-walled. Conidiogenous cells unilocal, hologenous, determinate or indeterminate very often with enteroblastic percurrent proliferations, showing 1-2- annellations and sometimes with holoblastic sympodial extensions; subhyaline. Conidia solitary, acrogenous, obovate, globose to pyriform, 1-distoseptate, 10-14 x 8-10 μm, smooth-walled, olivaceous-brown to pale brown.

Cultures deposited: INIFAT C02/6 = MUCL 45631 and INIFAT C02/10-1.

Fig. 4

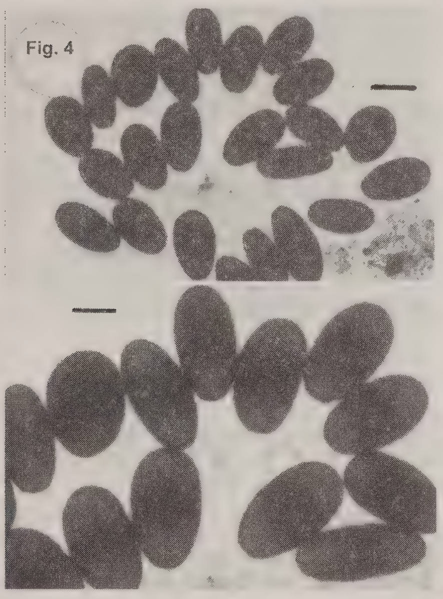
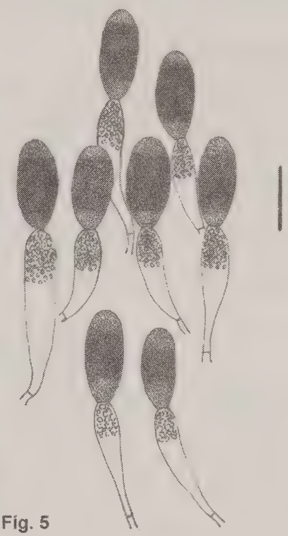


Fig. 5



Figs. 4-5. *Vanakripa fasciata*. Separating cells and conidia. **Fig. 4**: Photomicrographs. Scale is indicated by bars. Above: Bar = 20 μm; below: Bar = 10 μm. **Fig. 5**: Drawings. Scale is indicated by bar (20 μm).

Vanakripa fasciata R.F. Castañeda, M. Stadler et Decock. anam. sp. nov.

FIGURES 4-5

> *Ad omnibus speciebus Vanacripae differt in cellulae separabiles clavatae, 17-30 x 6-9 µm, multiguttulatae ad apicem, laeves, hyalinae et in conidia solitaria, acrogena, ellipsoidea usque ad late fusiformes, rotundata ad apicem, laevia, 24-34 x 13-22 µm, unicellularia, brunnea vel atrobrunnea, sed nigra fasciata ad zona centrali, persistentia in cellulis separabilis adnata.*
>
> Etymology: Latin, *fasciatus*, referring to the central black transverse zone or band-shaped of conidia.

Colonies on natural substratum effuse, black. **Conidiomata** sporodochial, scattered, pulvinate. Mycelium superficial and immersed composed of septate, branched, 1.0-1.5 μm diam., hyaline, smooth-walled hyphae. **Conidiophores** undifferentiated, mononematous, hyaline, smooth-walled. **Conidiogenous cells** unilocal, hologenous, determinate, cylindrical, hyaline, integrate. **Separating cells** clavate, 17-30 x 6-9 μm, multi-guttulate towards the apex, smooth-walled, hyaline. **Conidiogenous loci** apical.

Conidial secession rhexolytic. **Conidia** solitary, acrogenous, ellipsoid to broadly fusiform, rounded at the apex, smooth-walled, 24-34 x 13-22 μm, one-celled, brown to dark brown, always with a black central zone or band-shaped; usually the conidia are persistent on separating cells attached. Teleomorph unknown.

TYPUS: **CUBA. Pinar del Rio:** Soroa, submerged decaying wood in a river, 20.XI.2002, leg. A. Sarregui (**MUCL 45276**-HOLOTYPUS; **INIFAT C01/70-3**-ISOTYPUS), culture MUCL 45276.

COMMENTS: Four species have been described in the genus *Vanakripa*: *V. gigaspora* Bhat, W.B. Kendr. & Nag Raj, the type species (Bhat & Kendrick 1993); *V. parva* Bhat, W. B. Kendr. & Nag Raj (Bhat & Kendrick (1993); *V. ellipsoidea* K. M. Tsui, Goh & K. D. Hyde (Tsui et al. 2003) and *V. minutiellipsoidea* Pinnoi (Pinnoi et al. 2003). Among these taxa *V. fasciata* is superficially similar to *V. minutiellipsoidea*. It has conidia 25-33 x 16-23 μm that are almost the same size of *V. fasciata,* but conidia in *V. minutiellipsoidea* are ellipsoid (not broadly fusiform), and the separating cells are 31-70 x 16-23 μm, whereas in the *V. fasciata* the conidia are ellipsoid to broadly fusiform with a distinctive black central zone and separating cells measure 17-30 x 6-9 μm.

Key to *Vanakripa* species

1 **Conidia one-celled** *2*

1* **Conidia with a submedian septum,** clavate to pyriform, smooth-walled, dark brown to black, basal cell pale brown, 33-40 x 19-23 μm; separating cells vermiform, 18-70 x 6-8 μm, smooth-walled, hyaline .... ***V. gigaspora***

2 **Conidia small,** 7-10 x 4-6 μm, ovoid, with rounded apex, brown to dark brown, smooth-walled,; separating cells vermiform, 20-40 x 4-5 μm, smooth-walled, hyaline .... ***V. parva***

2* **Conidia much larger**, more than 24 x 16 μm **3**

3 **Separating cells relatively narrow,** 17-30 x 6-9 μm, clavate, hyaline. Conidia ellipsoid, with rounded apex, brown to dark brown with a black central zone or a black transverse band, smooth-walled, 24-34 x 16-23 μm .... ***V. fasciata***

3* **Separating cells much wider,** more than 10 μm **4**

4 **Conidia 25-33 x 16-23 μm,** ellipsoid, with rounded apex and base, dark brown to black, smooth-walled,; separating cells clavate to vermiform, 30-70 x 10-22.5 μm, hyaline .... ***V. minutiellipsoidea***

4* **Conidia longer,** 33-42 x 20-25 μm, ellipsoid, with rounded apex, dark brown to black, smooth-walled; separating cells clavate to vermiform, 30-72 x 11-16 μm, smooth-walled, hyaline .... ***V. ellipsoidea***

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Some additions to the *Graphidaceae* in the Andaman Islands, India

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Abstract—Five new species belonging to *Hemithecium,* subgenus *Hemithecium* and *Platythecium* in the family *Graphidaceae,* namely *H. aphaneomicrosporum, H. croceum, H. pulchellum, H. scariosum,* and *Platythecium parvicarpum,* are described from the Andaman Islands of India.

Key words—lichenized fungi, ascomycetes, taxonomy

Introduction

Nylander (1873) in "Lichenes Insularum Andaman" described eleven species of *Graphis,* which were distributed among the three lichen genera *Graphina, Graphis,* and *Phaeographina.* Since then, no other species of these genera were added until very recently when Makhija et al. (1992 a, b) recorded the occurrence of thirty four species of the spore genera *Graphina* (18), *Graphis* (8), *Phaeographina* (4), and *Phaeographis* (4) from this area. These species, in fact can now be distributed among different, well-defined genera (e.g. *Acanthothecis*, *Carbacanthographis*, *Dyplolabia, Fissurina, Hemithecium, Platythecium,* and other genera) in the new system of Staiger (2002).

Staiger (2002), in her recent treatment of the lichen family *Graphidaceae,* reintroduced the genus *Hemithecium* Trevis., which is distinguished from the other members of this family by well-developed & convergent labia, an uncarbonized and mostly distinctly crenate exciple with internal striae, a disc that is not visible, and puffy/swollen lateral excipular/labial hyphae that turn brown/reddish-brown in iodine [Lugol's]. In the same work Staiger (2002) also established a new genus *Platythecium* Staiger, characterized by an uncarbonized, divergent exciple (with carbonization restricted to the base), a poorly developed lateral exciple that forms only a narrow brownish layer, a disc visible in surface view, and a brown, yellow, flesh-coloured, or transparent disc without or with little pruina. During the course of our study on this family from India we have come across several new and interesting taxa from the Andaman Islands of India. In the present paper we are describing five species new to science that can be placed in *Hemithecium* and *Platythecium.*

Materials and Methods

Secondary products of the specimens were identified by thin-layer chromatography using methods standardized for lichen products (Culberson & Kristinsson 1970; Culberson 1972; White & James 1985) using solvent systems benzene-dioxane-acetic acid (180:45:5) and toluene-ethylacetate-formic acid (139:83:8). All specimens were examined under UV light (365 nm).

Taxonomic Descriptions

Hemithecium aphaneomicrosporum sp. nov. Figure 1

Type—India, Andaman Islands, North Andaman, Mayabander Range, Kaichi Nala, in moist deciduous forest, 30.12.1985, *M.B. Nagarkar & P.K. Sethy, 85.2757;* holotype: AMH.

> Similis *H. aphanes* (Mont. et Bosch) M. Nakan. & Kashiw., sed ascosporis minoribus differt.
>
> *Etymology:* from the species name aphanes, from the Greek micron, small and from Latin spore, a reference to the small ascospores as in aphanes.

Thallus brownish yellow to olivaceous, slightly glossy, irregularly cracked, delimited by a thin black hypothallus. **Ascomata** lirelline, concolorous with the thallus, 1–13 mm long, slender, simple to rarely branched, scattered, immersed, acute ends. **Disc** narrow, pale brown, epruinose. **Exciple** present below, entire, non carbonized, orange woody brown, convergent, covered by a thalline exciple till top. **Epithecium** thin, hyaline. **Hymenium** hyaline, clear, 85–105 μm high and 79–97 μm broad, I-. **Hypothecium** thin, hyaline, 16–21 μm high. **Periphyses** absent. **Paraphyses** simple, long, thick, unbranched. **Asci** 8 sporate, 77–112 x 11–14 μm. **Ascospores** 7–9-transeptate, ellipsoidal, 21–33 x 3–4 μm, I+ blue.

Chemistry—Thallus K+ red, C-, KC-, P-; UV-; stictic, constictic acids present.

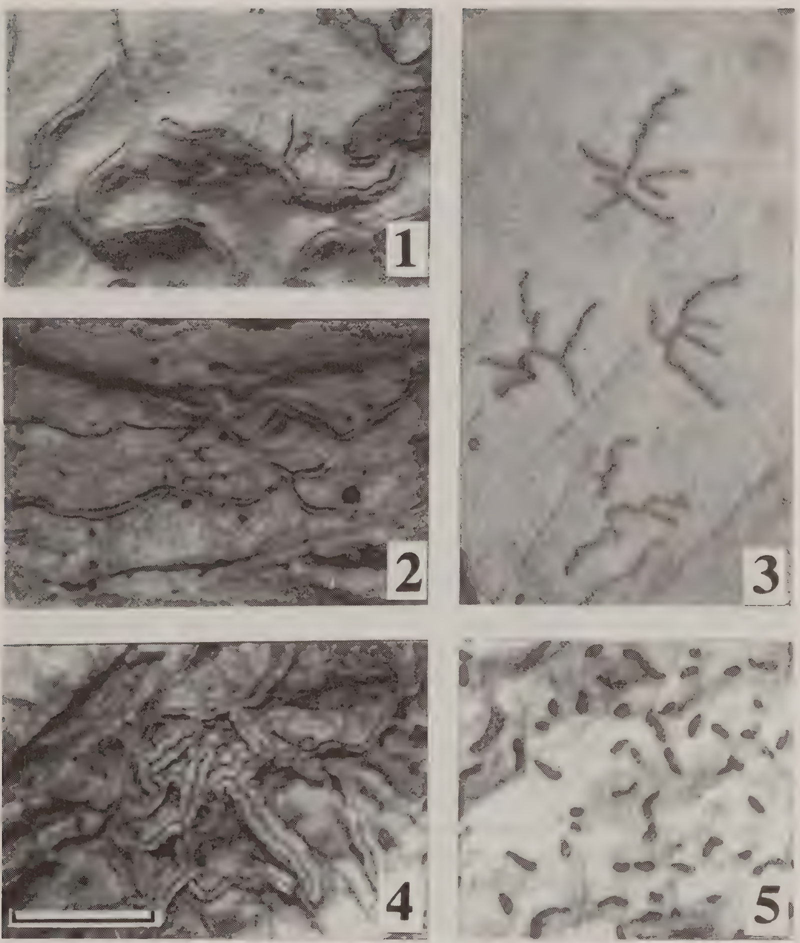
Specimens examined—Andaman Islands: North Andaman, Mayabander Range, Kaichi Nala, *PK. Sethy & PG. Patwardhan* 85.2843; Tugapur Range, Pathar Tikri, *MB. Nagarkar & PG. Patwardhan* 85.2557, 85.2531, 85.2532.

Remarks—*Hemithecium aphaneomicrosporum* is very similar to *Hemithecium aphanes* (Mont et Bosch) M. Nakan. & Kashiw., a species from Java, from which it differs in having much smaller ascospores. *H. aphanes* has ascospores of 80-100 μm long. The new species has been collected from the tropical rain forests of the Andaman Islands.

Hemithecium croceum sp. nov. Figure 2

Type—India, Andaman Islands, Middle Andaman, Betapur Range, Dhaninala, in moist deciduous forest, 26.12. 1985, *M.B. Nagarkar & P.G. Patwardhan, 85.2486;* holotype: AMH.

> Similis *Graphis patula* AW. Archer, sed ascosporis minoribus differt.
>
> *Etymology:* from the Latin croseus, saffron coloured, a reference to the colour of disc.



Figures—1-5. Habit (Holotypes) 1. *Hemithecium aphaneomicrosporum*; **2.** *H. croceum*; **3.** *H. pulchellum*; **4.** *H. scariosum*; **5.** *Platythecium parvicarpum*. Bar = 2mm

Thallus greenish with white tinge to grayish green, rough, cracked, delimited by a thin black hypothallus. **Ascomata** lirelline, 3–7 mm long, simple to irregularly branched, scattered, immersed to semiemergent, acute to obtuse ends. **Disc** narrow, slit like, orange red, epruinose. **Exciple** present below, entire, non carbonized, yellowish to woody brown laterally convergent, covered by a thalline exciple till top. **Epithecium** thin, brown, K-. **Hymenium** hyaline, clear, 59–67 μm high and 120–130 μm broad, I-. **Hypothecium** indistinct, thin, pale. **Periphyses** absent. **Paraphyses** simple, long, thick, unbranched. **Asci** 6–8 sporate, 70–80 x 8–10 μm. **Ascospores** 6–7-transeptate, ellipsoidal, 16–21 x 4–5 μm, I+ blue.

Chemistry—Thallus K+ yellow, C-, KC-, P+ yellow; UV-; stictic acid present.

Remarks—The new species *Hemithecium croceum* is characterized by its semiemergent, irregularly branched lirellae; narrow, epruinose, reddish orange coloured disc; entire, non carbonized exciple and the presence of stictic acid in its thallus. *Graphis patula* AW. Archer from the Solomon Islands is apparently close to this species but has larger ascospores of 28–40 μm long (Archer, 2002).

Hemithecium pulchellum sp. nov. Figure 3

Type—India, Andaman Islands, North Andaman, Interview Island, Mayabander Range, in moist deciduous forest, 31.12.1985, *P.G. Patwardhan & P.K. Sethy, 85.2864;* holotype: AMH.

> Sicut *Graphis leptalocarpa* AW. Archer, sed ascosporis minoribus et acida sticticum, consalazinicum et norsticticum continens differt.
>
> *Etymology:* from the Latin pulchellus, beautiful, small, a reference to beautiful species.

Thallus off-white, pale beige, ± glossy, smooth, continuous to finely cracked, thin, delimited. **Ascomata** lirelline, 0.5–1.5 mm long, delicate, simple to radially to irregularly branched, narrow, thin, scattered all over the thallus in groups, immersed to slightly raised above the thallus, acute to obtuse ends. **Disc** narrow, dark reddish brown, epruinose. **Exciple** entire, non carbonized, orange yellowish, convergent. **Epithecium** thin, hyaline to pale brown. **Hymenium** hyaline, clear, 58–67 μm high and 63–71 μm broad, I-. **Hypothecium** indistinct, thin, pale. **Periphyses** absent. **Paraphyses** simple, long, thick, unbranched. **Asci** 8 sporate, 50–70 x 10–12 μm broad. **Ascospores** 8–9-transeptate, ellipsoidal, 16.8–25 x 3–4 μm, I+ blue.

Chemistry—Thallus K+ red, C-, KC-, P+ orange; UV-; stictic, consalazinic and norstictic (trace) acids present.

Remarks—This beautiful new species appears somewhat similar to *Graphis leptalocarpa* Archer from the Solomon Island (2002) in its overall morphology, which, however, differs from the present new species in having large ascospores of 32–42 x 6–7 μm and a laterally carbonized exciple. *Hemithecium pulchellum* has much smaller ascospores of 16.8–25 x 3–4 μm and a non carbonized exciple. Moreover, it contains consalazinic and norstictic (trace) acids in addition to the stictic acid.

Hemithecium scariosum sp. nov Figure 4

Type—India, Andaman Islands, Middle Andaman, Long Island, on the way to Lalaji, 22.12.1985, M.B. Nagarkar & P.G. Patwardhan, 85.2120 (Holotype-AMH).

> Similis *Hemithecium implicatum* (Fée) Staiger, sed ascosporis majoribus et acida sticticum, salazinicum et consticticum continens differt.
>
> *Etymology:* from the Latin scariosus, not green, a reference to the thallus colour and texture.

Thallus greenish-stramineous, rough, thick, cracked, smooth to somewhat wrinkled, unevenly thickened. **Ascomata** lirelline, 1–4 mm long, irregularly branched, flexuose, concolorous with the thallus, scattered, immersed to slightly raised, acute ends. **Disc** narrow, light brown, epruinose. **Exciple** present below, entire, non carbonized, woody brown, convergent, totally covered by a thalline exciple with distinct corticiform layer.

Epithecium thin, hyaline. **Hymenium** hyaline, clear, 100–109 μm high and 142–147 μm broad, I-. **Hypothecium** thin, hyaline, 12–16 μm high. **Periphyses** absent. **Paraphyses** simple, long, thick, unbranched. **Asci** 8 sporate, 120–125 x 10–12 μm. **Ascospores** 15–22-transeptate, ellipsoidal, 63–88 x 6–8 μm, I+ blue.

Chemistry—Thallus K+ red, C-, KC-, P+ orange; UV-; stictic, salazinic, constictic (trace) acids present.

Specimens examined—Andaman Islands: Middle Andaman, Long Islands, on the way to Lalaji, *PG. Patwardhan & MB. Nagarkar* 85.2116, 85.2120; Betapur Range, Pitcher Nala, in evergreen forest, *PG. Patwardhan & MB. Nagarkar* 85.2357.

Remarks—*Hemithecium scariosum* can easily be distinguished by its bright greenish stramineous, somewhat wrinkled thallus; concolorous, immersed to slightly raised ascomata; noncarbonized, entire exciple; 63–83 μm long ascospores and has constictic, salazinic and stictic acids in its thallus. This species somewhat resembles *H. implicatum* (Fée) Staiger in exciple nature and overall morphology, which, however, has smaller ascospores of 40–50 x 8–10 μm and has no lichen substances.

Platythecium parvicarpum sp. nov. **Figure 5**

Type—India, Andaman Islands, South Andaman, Baratang Island, Nilambur, 20.2.1985, *P.G. Patwardhan, 85.368*; holotype: AMH.

> *Platythecium parvicarpum* insignis thallo stramineo, plicato, ascomatis brunneis, brevis, 0.1–1 mm longis, ramosis, ascosporis incolores, 12–16 x 3–4 μm, 3–4-transeptatis, acidum deficiens.
>
> *Etymology:* from the Latin *parvus,* small and from the Greek *karpon,* fruit, a reference to small lirellae.

Thallus stramineus to slightly darker, smooth, slightly glossy, smooth to distinctly plicate, unevenly thick, cracked, delimited by thin black hypothallus. **Ascomata** lirelline, 0.1–1mm long and 0.25 mm broad, simple, blackish brown, in wet condition dark brown, scattered, semi-immersed, acute to obtuse ends. **Disc** visible and distinctly broader, open, brown, epruinose. **Exciple** non-carbonized, poorly developed on lateral sides, entire, divergent, covered by a thalline exciple till top. **Epithecium** indistinct. **Hymenium** hyaline, clear, 50–63 μm high and 134–147 μm broad, I-. **Hypothecium** indistinct, thin, pale yellowish. **Periphyses** absent. **Paraphyses** simple, long, thick, unbranched. **Asci** 8 sporate, 60–85 x 10–12 μm broad. **Ascospores** 3-transeptate, rarely 4-septate, ellipsoidal, 12–16 x 3–4 μm, I+ blue.

Chemistry—Thallus K-, C-, KC-, P-; UV-; no lichen substances present.

Remarks—*Platythecium parvicarpum,* not comparable with any other known species of this genus, is distinguished by its straw coloured, glossy, smooth to distinctly plicate thallus; minute, 0.1–1 mm, always simple, somewhat broader ascomata with reddish brown to black, epruinose disc; small, 12–16 x 3–4 μm ascospores and thallus without lichen substances.

The genus *Platythecium* is generally characterized by a poorly developed exciple on lateral sides but has a strongly developed base. The present species, in fact, has a laterally, as well as basally, poorly developed exciple.

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We are grateful to Dr. André Aptroot, CBS, Netherlands, and Dr. A.W. Archer, National Herbarium of New South Wales, Australia, for valuable comments on the manuscript. We are also grateful to the Department of Science and Technology, Government of India, New Delhi, India for the financial support.

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Decaisnella mediterranea, a new species on *Quercus faginea* from Spain

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Abstract- A new species, *Decaisnella mediterranea,* is described from Natural Park of Cabañeros, Spain, growing on *Quercus faginea.*

Key words- bitunicate ascomycetes, *Pyrenulales*

Introduction

The genus *Decaisnella* Fabre, characterized by the large ascomata, trabeculate pseudoparaphyses and large ascospores with distosepta, has been considered as a synonym of *Teichospora* (Arx & Müller 1975, Hawksworth & al. 1983). Barr (1979b) considered *Decaisnella* and *Teichospora* to be separate and arranged in different orders. Barr (1986) added two species from the lichenized genus *Titanella* (Barr 1979a) namely *T. macrospora* (Speg.) M.E. Barr and *T. pelorospora* (Dearn.) M.E. Barr), to the genus *Decaisnella.*

Barr (1986) recognized two series of species on the basis of ascospore shape: oblong ellipsoid with parallel sides and obtuse ends as in *D. spectabilis* Fabre, or ellipsoid fusoid tapering to obtuse or acute ends as in *D. amelanchieris* Fabre and *D. ephedrae* (Fabre) Fabre (Barr 1990). These two are only known from France. Barr (1990) provided a key for seven American species. A new species with fusiform ascospores growing on *Quercus faginea* is described.

Description

Decaisnella mediterranea Checa & M.N. Blanco sp nov. Fig. 1

Ascomata solitaria vel gregaria 2-4, erumpens aut superficialia, 0,6-1 mm diam. globosa, papillata, ostiolum prominens, sine clypeo. Asci bitunicati, cylindrici, 200-220-(270) x 20-25-(27) µm, 8 sporis biseriatis praediti. Ascosporae fusiformes, (66)-70-80-(82) x 12-14-(15) µm, transversaliter usque ad (12)-15-(17) longitudinaliter usque ad 1-(2), fuscae, cellulae terminales hyalina.

Etymology: in reference to the mediterranean substrate and area.

Specimens examined: *Typus.- **Spain, Ciudad Real**, property "El Caracol", National Park of Cabañeros (Ciudad Real) 30S 0375 4355, 30-V-2003, bark from livinge trees of Quercus faginea Lam., leg. J. Checa & M.N. Blanco (AH 32203-holotypus).Idem, 30-IV-2004 (AH 33904-paratypus).*

Ascocarps scattered or clustered in groups of 2-4, erumpent or superficial, 0,6-1 mm diam., globose, with a prominent and sulcate papilla, without clypeus. Asci clavate with a big ocular chamber visible when the ascospores are immature, with 8 biseriate ascospores, 200-220-(270) x 20-25-(27) μm. Pseudoparaphyses trabeculate. Spores fusiform, (66)-70-80-(82) x 12-14-(15) μm, with (12)-15-(17) transversal septa and 1-(2) longitunal septa, brown, with pallid ends, distoseptate in immature stages.

The ascospores have not germinated in PDA or MEA

Observations

These specimens fit with the description of the genus *Decaisnella,* but not with the already known species. According to Barr (1986, 1990) this new species must be included in the group with ellipsoid fusoid ascospores where *D. confluens* (Plowr.) M.E. Barr, *D. mammoides* (Ellis & Everh.) M.E. Barr and *D. peniophora* (Cooke) M.E. Barr & Boise are placed, as well as *D. amelanchieris* and *D. ephedrae*, but none fits with *D. mediterranea*. Among them *D. peniophora* (Cooke) M.E.Barr & Boise, is the closest related species, with spores of (67)-80-117 x (18)-24-35 μm, and 16-23 transverse septa and 3-6 longitudinal septa, which grows on periderm or decorticated wood.

In the group with oblong spores, *D. macrospora* (Speg.) M.E.Barr, grows on *Quercus* spp. and wider ascospores (78-110 x 20-26 μm).

Species on *Quercus* are also *D. confluens* (Plowr.) M.E.Barr and *D. thyridioides* (Sacc. & Speg.) M.E.Barr, but without such big spores.

Margaret Barr has reviewed the Spanish specimens and she has suggested to us that the material published by Bricaud & Roux (1994) as *D.* cf. *princeps* with spores 90 x 16 μm, in *Quercus ilex* from France, might be the same species. She studied it long ago and conserves an unpublished drawing by the authors. Dr. Roux has indicated to us that this material is now lost.

Acknowledgements

We want to express our gratitude to Dr. Margaret Barr and Dr. Larissa Vasilyeva for revision and expert criticism on the manuscript, and to the Project REN2002-01965.

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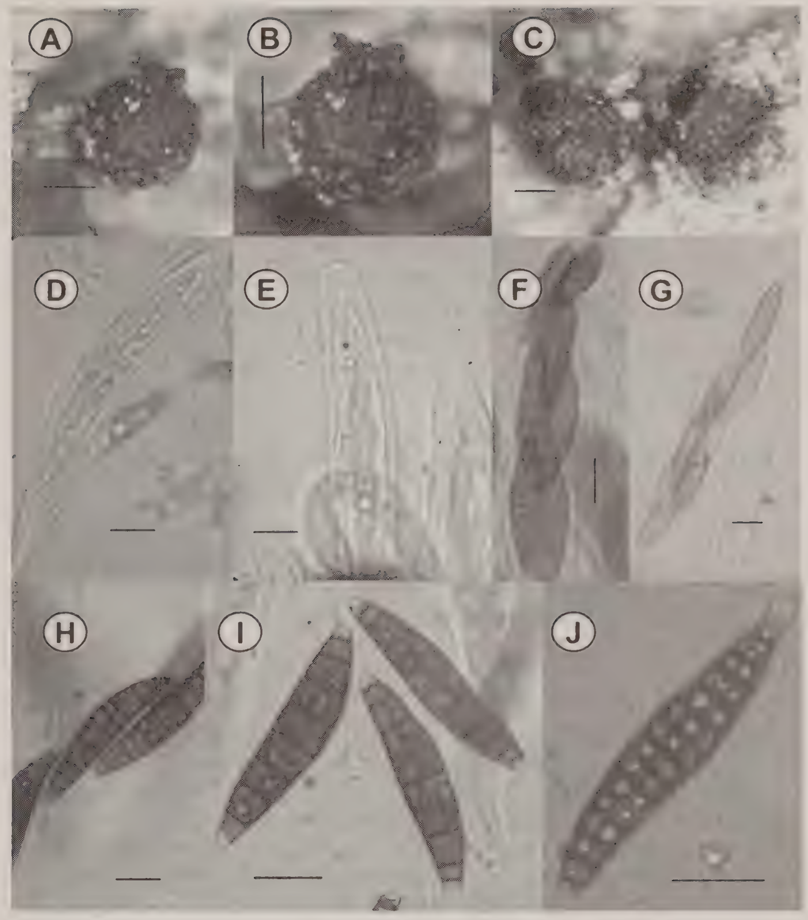

Fig. 1.- *Decaisnella mediterranea* (holotypus AH 32203). A, B, C. Ascocarps. D, E. Immature asci. F,G. Ascospores in asci. H-J. Mature ascospores. Scale bars. A-C = 0,5 mm. D-J = 20 μm.

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Ramularia uredinicola – a new species from Iran

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Abstract — *Ramularia uredinicola* sp. nov. on uredosori of *Melampsora* sp. on *Salix babylonica* in Iran is described, illustrated and compared with allied taxa.

Key words — hyperparasitic hyphomycetes, mitosporic fungi, taxonomy

Introduction

During a survey of phytoparasitic fungi in the Guilan Province, Iran, a *Ramularia* sp. was found associated with *Melampsora* sp. on *Salix babylonica*. According to the monograph of *Ramularia* Unger (Braun 1998), there are six hyperparasitic *Ramularia* species, including three species associated with *Melampsora* and other rust fungi, and two leaf-inhabiting species on hosts of the *Salicaceae*. The Iranian collections on *Salix babylonica* proved to be different from all hyperparasitic *Ramularia* species and non-hyperparasitic taxa on hosts of the *Salicaceae* and represents a new, undescribed species.

Material and Methods

Leaves of *Salix babylonica* infected by *Melampsora* sp. were collected in 2003 and 2004. Examinations of uredosori were carried out by means of a stereo-microscope to find hyperparasitic *Ramularia* colonies, which were transferred into culture (PDA). Conidiophores and conidia were stained with cotton blue and examined using a light microscope. Cross sections through infected uredosori were made with a microtome. Measurements were taken in lactic acid (50 %), based on 50 conidiophores, conidia, etc. Detailed field observations were carried out in June and August 2004.

Taxonomy and Discussion

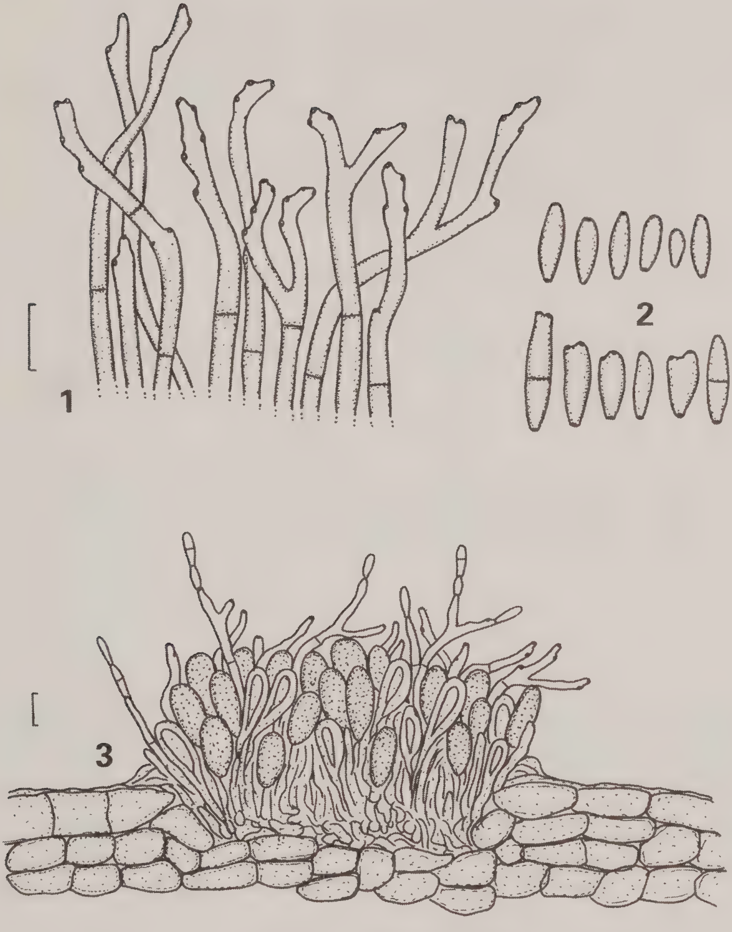
Ramularia uredinicola Khodap. & U. Braun, *anam. sp. nov.* **Figs 1-3**

> *Differt a Ramularia rosea et R. uredinis conidiophoris longioribus, ramosis, hyphis superficialibus cum conidiophoris solitariis evolutis et a R. uredinis insuper coloniis rubellis.*

Caespituli confined to uredosori of *Melampsora* sp., punctiform to effuse, at first whitish, with a pale reddish or pink tinge with age. **Mycelium** superficial and immersed, hyphae septate, sparingly branched, 1.5-3.0 μm wide, smooth to faintly rough-walled, thin-walled, hyaline. **Stromata** lacking. **Conidiophores** in small to moderately large, loose to moderately dense fascicles, arising from hyphae immersed in uredosori, or occasionally solitary, arising from superficial hyphae, erect, straight, subcylindrical to geniculate-sinuous, unbranched or branched, (10-)20-80(-120) × 2-4 μm, septate, thin-walled, smooth, hyaline, old conidiophores sometimes with a pale reddish tinge. **Conidiogenous cells** integrated, terminal, 10-25 μm long, sympodial, cicatrized. **Conidiogenous loci** conspicuous, 1.0-1.5 μm wide, somewhat thickened and darkened. **Conidia** catenate, in simple or branched chains, ellipsoid-ovoid, fusiform, subcylindrical, 4-15(-21) × 2-4(-5) μm, 0-1-septate, hyaline, old conidia sometimes with a pale reddish or olivaceous tinge, thin-walled, smooth to rough-walled, ends rounded to attenuated, with 1-4 conspicuous hila, 1.0-1.5 μm wide, somewhat thickened and darkened, conidial secession schizolytic. Colonies on PDA at first whitish, but turning pink with age. Teleomorph unknown.

> **TYPUS**: on uredosori of *Melampsora* sp. (Uredinales), on *Salix babylonica* L. (Salicaceae), Iran, Province Guilan, Sumaehsara, 3 Jul. 2004, S.A. Khodaparast (**IRAN 12316 F** — HOLOTYPUS; HAL 1820 (F) and Guilan University, College of Agriculture, Mycological Herbarium No. 272 — ISOTYPI); culture in Guilan University, College of Agriculture, Rasht, Iran.
>
> **ADDITIONAL MATERIAL EXAMINED:** IRAN, Guilan Province, Sumaehsara, 12 Oct. 2001 (no. 266), Rasht, 10 Dec. 2003 (no. 265), Amlash, 21 May 2004 (no.270), Rasht, 5 Jun. 2004 (no. 269), Amlash, 21 Jun. 2004 (no. 271) [Guilan University, College of Agriculture, Mycological Herbarium].

Ramularia uredinicola is close to *Ramularia rosea* (Fuckel) Sacc., which occurs on leaves of *Salix* species. The two species are characterized by forming reddish or pink caespituli with age, probably caused by the production of rubellins (Arnone et al. 1986, Miethbauer et al. 2003). *R. uredinicola*, which is hyperparasitic, differs from the latter species, which is a leaf-spotting fungus, in having much longer, sometimes branched conidiophores and superficial hyphae with solitary conidiophores. *Ramularia rosea* may occur on leaves together with uredosori of *Melampsora* spp., but not as a hyperparasite. *Ramularia uredinis* (W. Voss) Sacc. is also known as hyperparasite on uredosori of *Melampsora* spp., but the caespituli are whitish and do not turn reddish with age. The conidiophores are much shorter and unbranched. The colonies of *Ramularia coleosporii* Sacc. and *R. uredinearum* Hulea, two additional species which are hyperparasitic on rust fungi, are also consistently colorless (Braun 1998).



Figs 1-3. *Ramularia uredinicola anam. sp. nov.*; 1 – conidiophores, 2 – conidia, 3 – section through an infected uredosorus. Scale – 10 μm.

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Studies on the genus *Paecilomyces* in China
II. *Paecilomyces* spp. from Guizhou

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Abstract —Eight species of *Paecilomyces,* one new to science, were isolated from soil sampled from Huaxi in Guizhou Province. Diagnostic features of the new species, *P. huaxiensis,* are (1) colony saffron-yellow on Czapek agar, (2) phialides consisting of more or less cylindrical bases that taper abruptly to a long thin neck in compact whorls, and (3) small, ellipsoidal conidia.

Key words —fungi, taxonomy, morphology

Introduction

Eight strains of *Paecilomyces* were isolated from fifty-three soil samples from Guizhou Province (Fig.1-10). They are *P. carneus* (Duché & R. Heim) A.H.S. Br. & G. Sm. (Pu & Li 1996), *P. cateniannulatus* Z.Q. Liang (Liang 1981), *P. griseoviridis* M.X. Dai (Dai 1998), *P. huaxiensis*, *P. javanicus* (Friedrichs & Bally) A.H.S. Br. & G. Sm. (Liang et al. 1993), *P. marquandii* (Massee) S. Hughes (Han et al. 2003), *P. puntonii* (Vuill.) Nann. (Han et al. 2003), and *P. variotii* Bainier (Tai 1979). *P. huaxiensis* represents a new species whose Latin description and diagnosis are provided below.

Materials and Methods

Collection and strain isolation

Authors Han and Liang isolated strain GZDX-IFR51-01 from soil surrounding a corn root system from Huaxi, Guiyang, Guizhou Province, China. Two grams of soil were added to a flask containing 20ml sterilized water and glass beads. The soil suspension was diluted to a concentration of 10^{-1}-10^{-3} after shaking for about 10min. A 1-ml soil suspension (concentration 10^{-3}) was mixed with Martin medium in sterilized 9 cm diam Petri dish, then incubated at 25°C for 5 days. Colonies showing conidiogenous structure of *Paecilomyces* were then purified by transplanting to Martin's slants.

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* Corresponding author

Strain identification

The strains were transplanted onto Czapek agar, potato dextrose agar (PDA), and Sabouraud agar in accordance with procedures set forth in Brown and Smith (1957) and Samson (1974). After incubation at 25-26°C for 14 days, strains were identified based on colony characters, conidiogenous structures, and other biological features.

The type strain of *P. huaxiensis* GZDX-IFR51-01 and the holotype GZDX51-01, a dried plate culture on Czapek agar, were deposited in the Institute of Fungus Resources, Guizhou University, China.

Key to *Paecilomyces* spp. from Guizhou, China

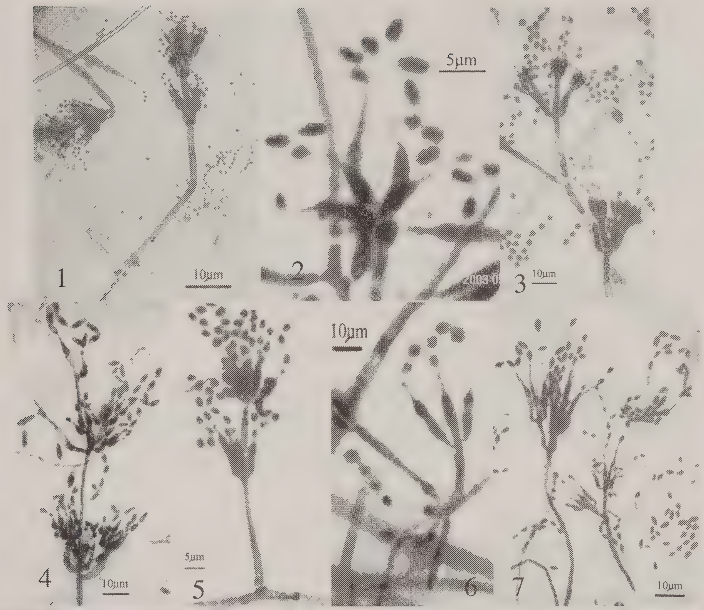
1. Colonies saffron-yellow, reverse scarlet in the middle, and gradually becoming yellow towards the margin . . . . *P. huaxiensis*
1'. Colonies in other colours 2
  2. Colonies purple, reverse scarlet . . . . *P. marquandii*
  2'. Colonies gray green, yellow, pink or white 3
3. Colonies gray green, conidia fusiform . . . . *P. griseiviridis*
3'. Colonies yellow, pink or white 4
  4. Colonies olive yellow, reverse tawny . . . . *P. variotii*
  4'. Colonies pink or white 5
5. Colonies pink, conidiophores very long, up to 158 μm . . . . *P. carneus*
5'. Colonies white 6
  6. Conidia in straight chain 7
  6'. Conidia ellipsoidal to cylindrical, always in ring . . . . *P. cateniannulatus*
7. Conidia mostly fusiform, 5-7.4 × 1.4-1.7 μm . . . . *P. javanicus*
7'. Conidia ellipsoidal to cylindrical, 3-5 ×1.5-2 μm . . . . *P. puntonii*

Description of new species

Paecilomyces huaxiensis Z. Q. Liang & Y. F. Han **sp. nov.** **Fig. 8-11**

> *In agaro Czapekii coloniae 45–49 mm diam in 14 diebus ad 25°, planae humiles, densae citrinae, margine albae, reserso citrinae. Hyphis 1.2–3 μm crassis. Conidiophora breva, 27–45 μm longa. Phiales 7–18 × 0.6–1.8μm, e parte basilari cylindrical. Conidia ellipsoidea vel ovoida, catenulatae, 1.2–2.4 × 0.9–2 μm.*
>
> *Typus: GZDX-IFR51-01 et cultara viva GZDX51-01, isolatus e rhiza regio Huaxi, Guiyang, Provinica Guizhou, VI, 2003, Y.F. Han & Z.Q. Liang; in Guizhou Univ., conservatur.*
>
> Etymology: From *huaxi,* referring to the locality of this interesting fungus.

Colonies on Czapek agar usually growing rapidly, attaining a diameter of 45-49 mm within 14 days at 25°C; dense felted, flat, giving a powdery appearance, sometimes with tiny dewdrop; yellow in middle, then saffron yellow, white with margin; after long culture becoming red; reverse scarlet, saffron yellow to yellow from center to margin; vegetative hyphae septate, hyaline, smooth-walled, 1.2–3 μm wide. *Conidiophores*



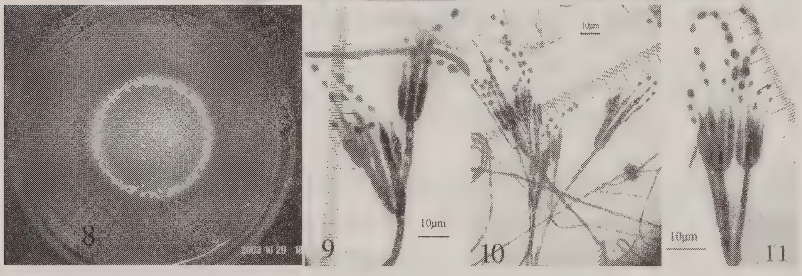


Fig. 1-7. *Paecilomyces* from Guizhou, China **1.** *P. carneus*; **2.** *P. cateniannulatus*; **3.** *P. griseiviridis*; **4.** *P. javanicus*; **5.** *P. marquandii*; **6.** *P. puntonii*; **7**. *P. variotii*.

Fig. 8-11. Colony and conidiogenous structure of *P. huaxiensis* **8.** Colony; **9-11.** Conidiogenous structure.

short, hyaline, smooth-walled, 27-45 μm, with whorls of 2 to 4 phialides. *Phialides* 7–18 × 0.6–1.8 μm, consisting of a narrowly cylindrical basal portion, tapering into a thin neck, less than 0.5 μm wide. Conidia one-celled, hyaline, smooth-walled, mostly ellipsoidal to ovate, 1.2–2.4 × 0.9–2 μm, forming divergent, dry chains.

Paecilomyces is distinguished from *Penicillium* by the shape of phialides, the irregular or verticillate branching of the conidiophore, and the divergent conidial chains (Brown & Smith 1957, Samson 1974). *P. huaxiensis* is similar to *Penicillium* in the shape of phialides and the compact whorls, but its conidiogenous cells have thin, long necks and its conidia are ellipsoid/ovoid instead of spherical.

The species related to strain GZDX-IFR51-01 were identified by searching the CBS, Centraalbureau voor Schimmelcultures Database of Fungal Names and our own *Paecilomyces* database following species concepts set forth in Brown and Smith (1957), Chen and Chen (1996), and Samson (1974). The species are *P. taitungiacus* K.Y. Chen & Z.C. Chen, *P. zollerniae* Stolk & Samson, *P. niveus* Stolk & Samson, *P. puntonii*, *P. variotii*, *P. coleopterorum* Samson & H.C. Evans, and *P. clavisporus* Hammill. Among them, *P. clavisporus*, *P. zollerniae*, *P. niveus* and *P. taitungiacus* are thermophilic and do not produce yellow colonies (Samson 1974). Conidia size and colour of the other related species also differ from *P. huaxiensis* (Samson 1974). The conidia sizes of *P. puntonii* (3–5 × 1.5–2 μm), *P. variotii* (3.2-5 × 2-4 μm), *P. variotii* (3.6-5 × 1.5-3 μm), and *P. coleopterorum* (5.7-8.5 × 2.5-3 μm) are larger than those of the new species.

Acknowledgements

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Lepiota pseudoasperula (Agaricaceae), new to Russia

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Abstract—A new record of the rare *Lepiota pseudoasperula* is described from the Samara Region in the southern part of European Russia. The general morphology and spore variability are discussed and its present known distribution summarized.

Key words—*Agaricales*, Basidiomycetes, new records

The agaric *Lepiota pseudoasperula* Knudsen belonging to *Lepiota eriophora* complex is characterized by small fruitbodies with relatively long stipe, small-sized and clearly dextrinoid spores, lack of cystidia and morphology of the velum (Knudsen 1980; Vellinga 2001). In 2000, new collections of this species were made in the Samara Region in southern Russia.

The variation of the species has been poorly known because of the few existing records. A description of the Russian records is therefore presented below.

Lepiota pseudoasperula (Knudsen) Knudsen, Bot. Tidsskr. **75:** 128, 1980.

Figs. 1–2, Table 1

≡ *Cystolepiota pseudoasperula* Knudsen, Bot. Tidsskr. **73:** 125, 1978
≡ *Echinoderma pseudoasperulum* (Knudsen) Bon, Doc. Mycol. **21(82):** 61, 1991
Misappl. = *Lepiota eriophora* sensu D.A. Reid non Peck, Trans. Br. mycol. Soc. **41:** 426, 1958.

Pileus 1.5–2.5 cm in diam., convex to plano-convex with distinct umbo, light to pale cream, covered by small (0.5–0.7 mm thick), conical, dark brown (Munsell 5YR 3/3, 4/4–6 according to Vellinga 2001) scales, densely arranged in centre and scattered towards the margin; margin even, inrolled, with snow-like residual veil. **Lamellae** crowded, free, white then pale cream, more intensely colored when dried. **Stipe** 20–40 × 3–4 mm, cylindrical; lacking a membranous annulus ring none, but with well-developed cortina; surface at apex smooth, almost white, toward base brown-scaled and with a residual woolly tomentum with brown scales, above smooth, almost white.

Hyphae 5–8 μm in diam., thin-walled in subhymenium and trama, slightly thick-walled in flesh as well as in cap cuticle; parallel arranged in trama, loose in cap medulla; clamp

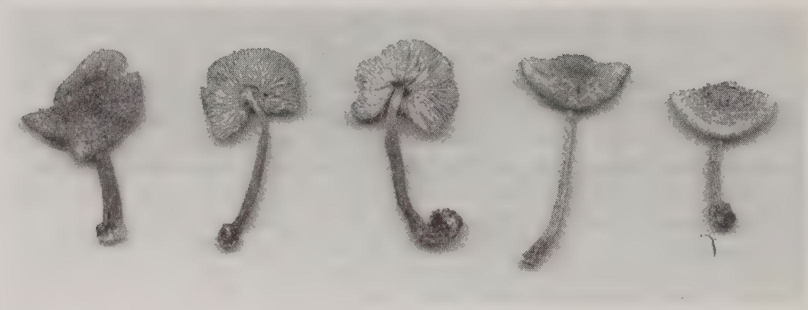

Fig. 1. *Lepiota pseudoasperula* (ZHSR 475), basidiomata (full-scale).

connections present. **Cylindrical scales** consist of subglobose or ovoid cells of 20–60 μm in diam. and hyphae 8–10 μm broad (Fig. 2). **Cystidia** none. **Basidia** 14–18(23.5) × 3.8–6.2 μm, clavate with a medial constriction, 4-spored, clamped at the base. **Basidiospores** 4–5 × 2.2–3 μm, ellipsoid, smooth, thin-walled, dextrinoid, (weakly) metachromatic in Cresyl Blue (data on spore-variability are shown in *Tab. 1*).

Habitat: in small groups on cretaceous soil; associated with mesic broad-leaf forests.

Specimens examined: Samara Region, Zhigulevsky State Reserve (ZHSR), in the vicinity of Bakhilova Polyana, *Acereto-Tilietum aegopodiosum*, 31 VIII 2000 (ZHSR 475, ZHSR 476, ZHSR 477).

Table 1: Spore variability in *Lepiota pseudoasperula* (Knudsen) Knudsen *(from Russian material, 90 basidiospores total)*

Specimen	L	L*	W	W*	Q	Q*
ZHSR 475	4.0–5.0	4.5	2.2–3.0	2.6	1.7–1.8	1.8
ZHSR 476	4.0–5.0	4.5	2.2–3.0	2.5	1.3–2.0	1.8
ZHSR 477	3.5–4.3	3.9	2.0–2.3	2.1	1.7–2.1	1.9

Abbreviations: **L** = spore length (in μm; 30 spores were measured); **L*** = the mean spore length (L* = Li/30; in μm); **W** = spore width; **W*** = the mean spore width (W* = wi/30; in μm); **Q** = range of the variation in L/W (Q = L/W); **Q*** = quotient of the mean spore length and the mean spore width (Q* = Qi/30); ZHSR: voucher kept in Zhigulevskii State Reserve.

The species has a superficial resemblance to *Lepiota jacobi* Vellinga & Knudsen (*L. langei* Knudsen nom illeg.), which, however, differs by larger basidiomata and the presence of a well-distinguished ring. The difference in micromorphological features between *L. jacobi* to *L. pseudoasperula* lies mainly in the shape of the apical cells in the cap cuticle and in the occasional presence of hyphae-like cystidia in *L. jacobi*. Also, according to Vellinga (2001), "*L. pseudoasperula* is often mistaken for *Cystolepiota moelleri* (and vice versa) in the field. The microscopical data, viz. cheilocystidia absent in *Lepiota pseudoasperula*, present in *Cystolepiota moelleri*, and spores dextrinoid in *L. pseudoasperula* and non-dextrinoid in *C. moelleri*, are decisive…."

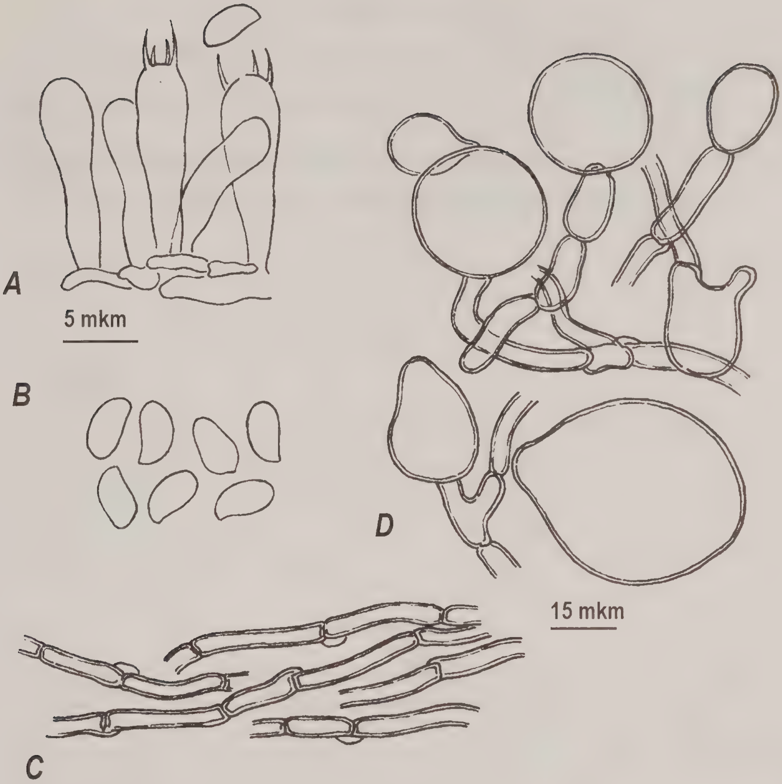

Fig. 2. *Lepiota pseudoasperula* (ZHSR 475): A. Basidia; B. Basidiospores; C. Medullary hyphae; D. Pileus cuticular hyphae.

The species was previously known from most of western Europe (Norway, Denmark, England, The Netherlands, Belgium, Germany, France, Italy) and Morocco (all summarized in Courtecuisse & Duhem, 1995). The new Russian records extend the distribution of this species more than 2000 km to the east.

Acknowledgements

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Some new species of *Graphis* (Lichenised Ascomycota) from the Andaman and Nicobar Islands of India

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Abstract — Ten new species of the lichen genus *Graphis,* namely *G. argentius, G. chloroalba, G. dispersa, G. distincta, G. flavovirens, G. insularis, G. leptocarpoides, G. longissimea, G. palmicola* and *G. sitapurensis,* have been recorded from the Andaman and Nicobar Islands of India. The genus is recorded for the first time from the Nicobar Islands of India.

Keywords — lichens, *Graphidaceae*, taxonomy

Introduction

The lichen family *Graphidaceae* is particularly well represented in India. However, several graphidaceous lichen taxa from the regions which are not easily accessible, such as the Andaman and the Nicobar Islands, as well as some difficult genera and species complexes, remain to be studied. We are currently undertaking a detailed survey of this family in India and we have discovered several taxa new to science.

The Andaman and the Nicobar Islands of India, from a botanical point of view, have a special position in the Indian subcontinent for their interesting flora. The vegetation is typically a tropical one. Being separated by a considerable stretch of sea from the Indian mainland there are remarkable floristic differences compared to the mainland vegetation and there are a large number of Malaysian elements due to proximity in addition to endemic taxa due to the insular position. The flora of Nicobar is still in its original form, unmixed and untouched by man owing to its isolated position. It may therefore be assumed that its flora may still contain a number of new and endemic species. The pyrenocarpous, graphidaceous lichens and thelotremes, which are corticolous in nature, predominate in the lichen flora of these islands (Makhija & Adawadkar 1999).

Awasthi (1991) recorded only two species of *Graphis* namely *G. circumradians* Nyl. (material from the Andaman is sterile) and *G. subdisserpens* Nyl. from the Andaman Islands.

Based on the recent collections made by Dr. P.G. Patwardhan and his associates in the Andaman and Nicobar Islands of India during the period 1985-88, Makhija *et al.* (1992) reported eight species of the spore genus *Graphis* Adans. from this area. These species, in fact can now be distributed among different, well defined genera (e.g. *Dyplolabia, Fissurina,* and *Hemithecium* etc.) in the new system of Staiger (2002) and will be so treated in a forthcoming paper.

Three species of *Graphis,* namely *G. chlorotica* Massal. & Krempelh., *G. persulcata* Stirton and *G. subdisserpens* Nyl., are so far known from the Andaman Islands. The genus has not previously been reported from the Nicobar Islands but four species are here reported from these Islands. Ten taxa, which are characterised by a well developed exciple with distinctly carbonised areas, and hyaline ascospores turning I+ blue and clearly belonging to the genus *Graphis sensu* Staiger (2002), are recorded from the Andaman and Nicobar Isalnds of India and are new to science. All these species have transeptate ascospores.

The occurrence of four species are the first record of this genus from the Nicobar islands.

Materials and Methods

Sections of thalli and ascomata were mounted in water, 10% KOH (K), Lugol's solution (I), and lactophenol cotton-blue (LPCB). All measurements were made in water. The iodine reaction of the asci was studied in Lugol's solution after pretreatment with K. The secondary products of the specimens were identified by thin-layer chromatography using methods standardized for lichen products (Culberson & Kristinsson 1970; Culberson 1972; White & James 1985) using the solvent systems benzene-dioxane-acetic acid (180:45:5) and toluene-ethylacetate-formic acid (139:83:8). All specimens were examined under UV light (365 nm).

We have had available to us the morphological and chemical data, based on the re-examination of type or authentic material of several taxa in the *Graphidaceae* together with photographs of type specimens from the late Dr. Mason Hale, which was provided to us by him for our studies during his several visits to our laboratory at ARI.

Key to the species

1a. Exciple striate **2**

1b. Exciple entire **4**

2a. Exciple completely carbonised
Ascomata 0.5-3 mm long, black, semi-emergent; exciple 3–4 striate on each side; ascospores 30–50 x 6–10 μm; no lichen substances present . . . . ***G. persulcata***

2b. Exciple carbonised only at the tip **3**

3a. Thallus gray, greenish white, smooth; ascomata 0.3–7 mm long, simple to dendroidly branched, concolorous, ends acute; exciple present at the base, 2–3 striate on each side; ascospores 4–8-transeptate, 21–25 x 4–8 μm in size; no lichen substances present. . . . . ***G. chloroalba***

3b. Thallus gray-white; ascomata 1.5–5 (-6) mm long, black, immersed to semi-emergent, branched; exciple 2-3 striate on each side; ascospores 7–9-transepate, 32–45 x 5–8 μm; no lichen substances present . . . . ***G. chrlorotica***

4a. Exciple partially carbonised. **5**
4b. Exciple completely carbonised. **9**

5a. Ascospores more than 50 μm long.
Thallus pale grayish; ascomata 1–5 mm long, immersed to semi-emergent, simple to irregularly branched, ends subacute; exciple entire, present below, laterally carbonised; ascospores 13–17-transeptate, 63–84 x 4–8 μm; constictic and stictic acids present . . . . ***G. sitapurensis***
5b. Ascospores less than 50 μm long **6**

6a. Lichen substances absent.
Thallus glaucous green, membrancaeous; ascomata 1–15 mm long, black, simple to sparsely branched, ends acute to round; disc narrow; exciple entire, present below, laterally carbonised; ascospores 10–14-transeptate, 38–46 x 4–6 μm in size; no lichen substances. . . . . ***G. leptocarpoides***
6b. Lichen substances present **7**

7a. Ascomata black
Thallus whitish, stramineous, ferinaceous, evanescent, flaking; ascomata 1–7 mm long, black, immersed, simple, radiately to irregularly branched; exciple entire, present below, laterally carbonised; ascospores 7–9-transeptate, 21–34 x 4–5 μm in size; constictic, salazinic, and stictic acids present . . . . ***G. insularis***
7b. Ascomata concolorous with the thallus **8**

8a. Thallus greenish, warty; ascomata 0.2–3 mm long, concolorous with the thallus, immersed, simple to branched, ends acute to subacute; exciple entire, present below, laterally carbonised; ascospores 7–9-transeptate, 21–34 x 4–5 μm in size; constictic, protcetraric, and stictic acids present . . . . ***G. distincta***
8b. Thallus silvery white, glossy; ascomata 5–7 mm long, concolorous with the thallus, simple to branched, ends acute to subacute, immersed to slightly raised; exciple entire, present below, laterally carbonised; ascospores 6–7-transeptate, 21–25 x 45 μm in size; constictic, salazinic and stictic acids presents . . . . ***G. argentius***

9a. Lichen substances present. **10**
9b. Lichen substances absent. **11**

10a. Thallus glaucous gray; ascomata 0.2–16 mm long, simple to profusely branched, black, immersed, blunt to rarely acuminate ends; exciple entire, present at the base, completely carbonised; ascospores 3–9-transeptate, 16–42 x 4–8 μm in size; stictic and constictic acids present. . . . . ***G. flavovirens***
10b. Thallus stramineous, yellowish brown, uneven; ascomata 0.5–20 mm long, black, simple to rarely branched, immersed, ends round; exciple entire, present below, completely carbonised; ascospores 12–17-transeptate, 76–88 x 4–8 μm in size; constictic and stictic acids present . . . . ***G. longissimea***

11a. Ascospores less than 50 μm long.
Thallus grayish white; ascomata 1–6 mm long, black, simple, emergent, acute to obtuse ends; exciple entire, present below, completely carbonised; ascospores 4–12-trasneptate, 21–29 x 4–8 μm; no lichen substance .... ***G. palmicola***

11b. Ascospores more than 50 μm long **12**

12a. Thallus greenish gray; ascomata 3–10 mm long, dichotomously to dendroidly branched, semi-emergent to emergent; exciple entire, present at the base, completely carbonised; ascospores 10–16-transeptate, 36-70 x 6–10 μm; no lichen substances present .... ***G. subdisserpens***

12b. Thallus off-white; ascomata 1–6 mm long, black, simple to sparsely branched; emergent, acute to obtuse ends; exciple entire, present below, complete carbonisation; ascospores 12–15-transeptate, 54–67 x 6–8 μm in size; no lichen substances .... ***G. dispersa***

Taxonomic Descriptions

Graphis argentius Makhija & Adaw., *sp. nov.* **Figure 1**

Type—India, Andaman Islands**,** Middle Andaman, Long Island Range, Elphiston Bay, in the beach forest, 23.12.1985, *P.G. Patwardhan & M.B. Nagarkar 85.2226*; holotype: AMH.

Sicut *G. assimilis* Nyl., sed ascosporis minoribus et acida sticticum, consticticum et salazinicum continens differt.

Etymology: from the Latin *argenteus*, silvery, a reference to the distinctive thallus colour.

Thallus silvery-white, thin, glossy, smooth, delimited by thin black hypothallus. **Ascomata** lirelline, 5–7 mm long, simple to branched, concolorous with the thallus, scattered, immersed to slightly raised, terminally acute to obtuse. **Disc** 0.25–0.3 mm broad, pruinose. **Exciple** present below, entire, laterally carbonised, convergent or slightly divergent, covered by a thalline exciple to the top. **Epithecium** thin, brownish. **Hymenium** hyaline, clear, 63–84 μm high and 126–189 μm broad, I -. **Hypothecium** thin, pale orange yellow. **Paraphyses** simple, long, thick, unbranched. **Asci** 8 sporate, 80–90 x 6–8 μm. **Ascospores** 6–7-transeptate, ellipsoidal, 21–25 x 4–5 μm, I+ blue.

Chemistry—Thallus K+ red, C-, KC-, P+ orange; UV-; constictic, salazinic and stictic acids present.

Specimens examined—Andaman Islands: Middle Andaman, Long Island Range, Elphiston Bay, in beach forest, *PG. Patwardhan & PK. Sethy* 85.2228, 85.2231, 85.2232, 85.2251 (AMH).

Remarks—The beautiful new species *Graphis argentius* is distinguished by its silvery white, glossy, thin thallus; immersed ascomata with broad, pruinose disc; complete, entire, laterally carbonised exciple and presence of constictic, salazinic and stictic acids in its thallus.

The new species resembles *Graphis assimilis* Nyl. in its exciple characteristics and overall morphology but *G. assimilis* has larger ascospores, (25–) 30–40 x 6–9

μm, compared to 21–25 x 4–5 μm in *G. argentius*. The new species also resembles *G. guimarana* Vainio but that species also has larger ascospores, 28–47 x 8 μm, and contains norstictic acid (*fide* M. Hale *in sched.*) and is thus distinct from *G. argentius*.

Graphis chloroalba Makhija & Adaw., *sp. nov.* **Figure 2**

Type—India, Andaman Islands, North Andaman, Lamia Bay, from Kalipur, south east of Aerial Bay, in mixed forest, 5.1.1986, *M.B. Nagarkar & P.G. Patwardhan 86.529;* holotype: AMH.

> Similis *G. intermediella* Stirton et *G. glaucescens* Fée, sed ascosporis minoribus differt.
> *Etymology:* from the Greek *chloro*, green and from the Latin *albidus*, whtish, a reference to the thallus colour.

Thallus greenish white to gray, yellow or off-white within, smooth, cracked, delimited by black hypothallus. **Ascomata** lirelline, 0.3–7 mm long, 0.2 mm broad, concolorous with the thallus, simple to dendroidly branched, scattered, immersed to slightly emergent, separated from the thallus with a narrow fissure, irregular, flexuose, terminally acute. **Disc** blackish brown to black when exposed otherwise covered by white pruina, narrow. **Exciple** present at the base, striate, 2–3 striae on each side, apically carbonised, convergent, covered by a thalline exciple to the top, studded with crystals. **Epithecium** pale, thin. **Hymenium** hyaline, clear, 84–109 μm high and 117–134 μm broad, I-. **Hypothecium** yellow, 6–8 μm high. **Paraphyses** simple, long, thin. **Asci** 6–8 sporate, 90–110 x 10–12 μm. **Ascospores** 4–8-transeptate, ellipsoidal, 21–25 x 4–8 μm, I+ blue.

Chemistry— Thallus K-, C-, KC-, P-; UV-; no lichen substances present.

> **Specimens examined—Andaman Islands:** North Andaman, Lamia Bay, *PG. Patwardhan & MB. Nagarkar* 86.530, 86.606 (AMH); Middle Andaman, Betapur Range, Pitcher Nala, *PG. Patwardhan* 85.2395 (AMH); South Andaman, Wright Myo, *PG. Patwardhan & PK. Sethy* 86.719, 86.720 (AMH).

Remarks—*Graphis chloroalba* is distinguished by its greenish-white thallus, concolorous, dendroidly branched lirellae, 2–3 striate, apically carbonised exciple, ascospores, 21–25 x 4–8 μm and by the absence of lichen substances.

Graphis intermediella Stirton, from India, closely resembles the new species but has larger ascospores, 30–45 x 7–10 μm.

Graphis dispersa Makhija & Adaw., *sp. nov.* **Figure 3**

Type—India, Nicobar Islands, Kamorta, 17.1.1987, *P.G. Patwardhan & M.B. Nagarkar 87.314;* holotype: AMH.

> Similis *G. congesta* Müll. Arg. sed ascosporis minoribus et acidum norsticticum deficines differt.
> *Etymology:* from the Latin *disperses*, scattered, a reference to the scattered lirellae.

Thallus off white, rough, thin, cracked, delimited by thin black hypothallus. **Ascomata** lirelline, 1–6 mm long, 0.1–0.2 mm broad, black, mostly simple to rarely furcate, emergent, scattered, narrow, terminally acute to obtuse. **Disc** narrow, not clearly visible. **Exciple** present at the base, entire, completely carbonised, convergent, covered by a thalline exciple to the top, crystals within. **Epithecium** hyaline, thin, K-. **Hymenium**

hyaline, clear, 105–113 μm high and *ca,* 105–126 μm broad, sometimes inspersed with oil globules, I-. **Hypothecium** hyaline, thin. **Paraphyses** simple, long, thin. **Asci** 6–8 sporate, 90–100 x 8–10 μm. **Ascospores** 12–15-transeptate, ellipsoidal, 54–67 x 6–8 μm, I + blue.

Chemistry—Thallus K-, C-, KC-, P-; UV-; no lichen acids present.

Specimen examined—**Nicobar Islands**: Kamorta , *PG. Patwardhan & PK. Sethy* 87.312, 87.330 (AMH).

Remarks—*Graphis dispersa* resembles *G. congesta* (Fée) Müll. Arg., from Peru, in that both species possess completely carbonised exciple but the new species has much narrow ascospores, 54–67 x 6–8 μm, in contrast to those of *G. congesta* which are 50–75 x 9–15 μm. In addition *G. congesta* contains norstictic acid, absent from *G. dispersa.*

Graphis distincta Makhija & Adaw., *sp. nov.* **Figure 4**

Type—**India**, Andaman Islands, South Andaman, Port Mount, 14.2.1985, *P.G. Patwardhan, 85.26;* holotype: AMH.

Similis *G. arecae* Vainio, sed acidum protocetraricum continens differt.

Etymology: from the Latin *distinctus*, distinct, a reference to the distinct species.

Thallus grayish green, thick, distinctly cracked, warty. **Ascomata** lirelline, concolorous with the thallus, completely immersed, 0.2–3 mm long, simple to branched, scattered, terminally acute to obtuse. **Disc** narrow, black, covered by white pruina. **Exciple** present below, entire, laterally carbonised, convergent, covered by a thalline exciple to the top. **Epithecium** thin, hyaline to brown tinged, K-. **Hymenium** hyaline, clear, 63–84 μm high and 126–189 μm broad, I-. **Hypothecium** pale, yellowish, 16–21 μm high. **Paraphyses** simple, long, unbranched. **Asci** 8 sporate, 90–100 x 8–10 μm. **Ascospores** 7–9-transeptate, ellipsoidal, 21–33 x 4–6 μm broad, I+ blue.

Chemistry—Thallus K+ yellow, C-, KC-, P+ orange red; UV-; stictic acid, protocetraric and constictic (trace) acids present.

Remarks—The occurrence of protocetraric acid is uncommon in the genus *Graphis*. *Graphis candidata* Nyl., from Brazil, was reported to contain protocetraric acid (*fide* M.E. Hale, *in sched.*) but that species has now been transferred to the genus *Carbacanthographis* (Staiger 2002).

The new species is very similar to *G. aracae* Vainio, from the Philippines, but that species lacks protocetraric acid (*fide* M. Hale, *in sched*) in contrast to *G. distincta.*

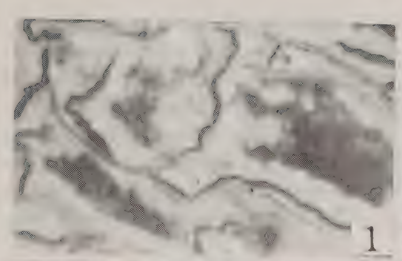
Graphis flavovirens Makhija & Adaw., *sp. nov.* **Figure 5**

Type—**India**, Andaman Islands, Middle Andaman, Parlobjig Island, 23.12.1985, *M.B. Nagarkar & P.K. Sethy 85.2264;* holotype: AMH.

Similis *G. subassimilis* Müll. Arg., sed ascosporis minoribus differt.

Etymology: from the Latin *flavescens*, green with yellow, a reference to the thallus colour.

Figures — 1–10. Habit (Holotypes) 1. *Graphis argentius*; **2.** *G. chloroalba*; **3.** *G. dispersa*; **4.** *G. distincta*; **5.** *G. flavovirens*; **6.** *G. insularis*; **7.** *G. leptocarpoides*; **8.** *G. longissimea*; **9.** *G. palmicola*; **10.** *G. sitapurensis*. Bar = 2mm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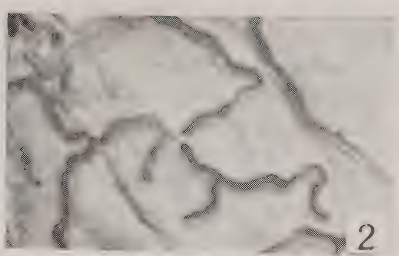
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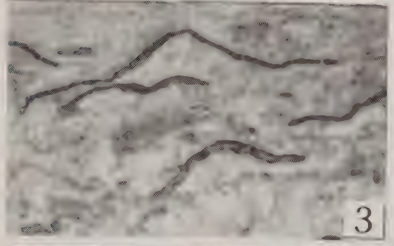
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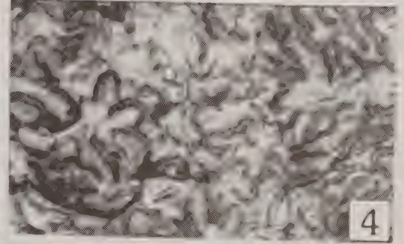
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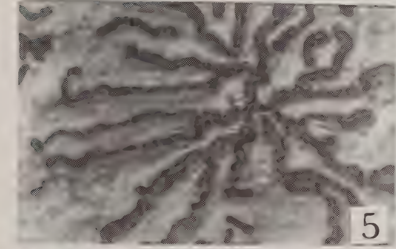
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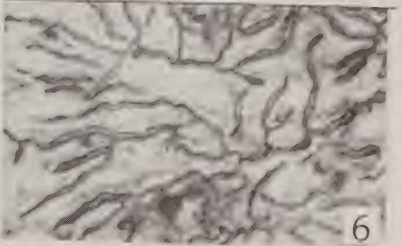
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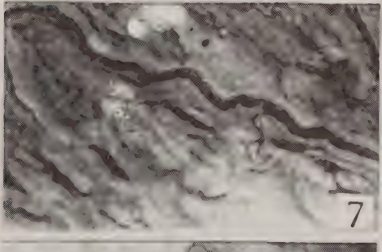
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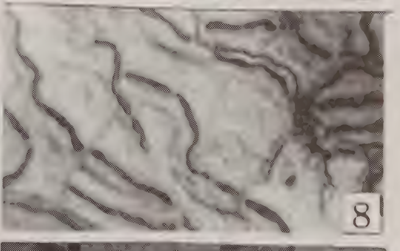
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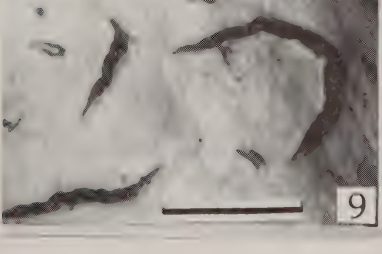
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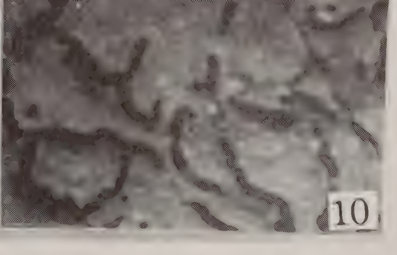
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Thallus light yellowish-green, thick, minutely cracked, delimited by thin black hypothallus. **Ascomata** lirelline, black, immersed, 0.2–16 mm long and 0.1 mm broad, simple to profusely, radiately, to irregularly branched, scattered, narrow, terminally blunt to rarely acuminate. **Disc** narrow, covered by white pruina. **Exciple** present at the base, entire, completely carbonised, convergent, covered by a thick thalline exciple to the top. **Epithecium** hyaline, thin. **Hymenium** hyaline, clear, 105–126 µm high and 147–210 µm broad, I-. **Hypothecium** indistinct. **Paraphyses** simple, long, thin, filiform, septate. **Asci** 8 sporate, 90–95 x 6–8 µm. **Ascospores** 3–9-transeptate, ellipsoidal, 16–42 x 4–8 µm, I+ blue.

Chemistry—Thallus K+ yellow, C-, KC-, P+ orange; UV-; constictic, and stictic acids present.

Remarks—The new species can easily be distinguished from all other species by its yellowish green, thick thallus; long, conspicuous, black, simple to radiately and profusely branched lirellae; entire, completely carbonised exciple and the presence of stictic and constictic acids.

Graphis subassimilis Müll. Arg., from Indonesia, is close to the present spceis but has larger ascospores, 60–68 x 7–8 µm which are 12–13-transeptate in contrast to the ascospores in *G. flavovirens* which are 16–42 x 4–8 µm and 3–9–transeptate. *Graphis longiramea* Müll. Arg., from India, also resembles the new species in its emergent, long lirellae but that species has a laterally carbonised exciple and larger ascospores, 55–62 x 10–12 µm; in addition it lacks constictic acid.

Graphis insularis Makhija & Adaw., *sp. nov.* **Figure 6**

Type—India, Andaman Islands, Middle Andaman, Guitar Island, near Long Island, 23.12.1985, *P.K. Sethy & M.B. Nagarkar 85.2158;* holotype: AMH.

> Similis *G. bakeri* Vainio et *G. bougainvillea* Zahlbr. sed acida sticticum, constiticum et salazinicum continens differt.
>
> *Etymology*: from the Latin *insula*, island, the type locality Andaman Island.

Thallus yellowish to whitish gray, rough, unevenly thickened, cracked with age, farinaceous, delimited by thin black hypothallus. **Ascomata** lirelline, black, immersed, 0.5–9 mm long, slender, radiately to irregularly branched, scattered, terminally acute to obtuse. **Disc** narrow, dark blackish brown, covered by white pruina. **Exciple** present below, entire, laterally carbonised, convergent, covered by a thalline exciple to the top. **Epithecium** thin, hyaline to pale yellowish brown, K-. **Hymenium** hyaline, clear, 75–109 µm high and 121–159 µm broad, I-. **Hypothecium** thin, hyaline, 12–16 µm high. **Paraphyses** simple, long, thick, unbranched. **Asci** 8 sporate, 95–100 x 8–10 µm. **Ascospores** 4–9-transeptate, ellipsoidal, 16–33 x 4–5 µm, I+ blue.

Chemistry—Thallus K+ yellow red, C-, KC-, P+ orange; UV-; stictic, constictic and salazinic acids present.

> **Specimens examined—Andaman Islands:** Middle Andaman, Guitar Island, *MB. Nagarkar & PK. Sethy* 85.2155, 85.2156, 85.2157, 83.2158, 85.2134, 85.2166 (AMH), Parlobjig Island, *PG. Patwardhan* 85.2262 (AMH); Little Andaman, South Bay, *MB. Nagarkar* 85.1023 (AMH); Netaji Nagar, Krishna Nala, *P.G. Patwardhan* 85.856a (AMH).

Remarks—The new species morphologically resembles both *G. bakeri* Vainio, from the Philippines and *G. bougainvillea* Zahlbr. but chemically is intermediate between these two species. The first contains salazinic acids and the second stictic and constictic acids (*fide* M. Hale *in sched.*) whereas *G. insularis* contains all three lichen compounds.

Graphis leptocarpoides Makhija & Adaw., *sp. nov.* **Figure 7**

Type—India, Nicobar Islands, Kamorta Island 17.1.1987, *P.K. Sethy & P.G. Patwardhan 87.348;* holotype: AMH.

> Similis *G. anfractuosa* Eschw., sed excipulo lateralis nigro et ascosporis minoribus differt.
>
> *Etymology:* from the Greek *lepto*, narrow and *karpos*, fruit, a reference to thin, narrow lirellae.

Thallus pale glaucous green, thin, very irregularly distributed in small elongate patches, discontinuous, apparently flaking, rough, membranaceous epruinose. **Ascomata** lirelline, 1–15 mm long and 0.1–0.2 mm broad, mostly simple to rarely and sparsely branched, black, immersed, terminally acute to round. **Disc** very narrow, thin, not seen. **Exciple** present at the base, entire, laterally carbonised, convergent, covered by a thalline exciple to the top. **Epithecium** hyaline, thin. **Hymenium** hyaline, clear, 122–126 μm high and 113–126 μm broad, I-. **Hypothecium** hyaline, 4–6 μm thick. **Paraphyses** simple, long, thin, filiform, septate. **Asci** cylindrical, 8 sporate, 100–110 x 4–8 μm. **Ascospores** 10–14-transeptate, ellipsoidal, 38–46 x 4–6 μm, I+ blue.

Chemistry—Thallus K-, C-, KC-, P-; UV-; no lichen substance present.

> **Specimen examined—Nicobar Island,** Kamorta Island, *PK. Sethy & MB. Nagarkar* 87.347 (AMH).

Remarks—*Graphis leptocarpoides* is distinguished by its long, thin, slender, slightly branched, black lirellae; exciple entire, present at the base, only laterally carbonised, and thallus lacking lichen substances.

The new species is somewhat similar to *Graphis anfractuosa* Eschw., which, however, has completely carbonised exciple and large ascospores 45-60 x 7-10 μm (Nakanishi 1966). *Graphis leptocarpoides* also resembles *G. sauroidea* Leighton, from Brazil, but differs from that species in having a laterally carbonised exciple and smaller ascospores.

Graphis longissimea Makhija & Adaw., *sp. nov.* **Figure 8**

Type—India, Andaman Islands, North Andaman, Pathar Thikri, Tugapur Range, deciduous forest, 29.12.1985, *P.K. Sethy & P.G. Patwardhan 85.2715;* holotype: AMH.

> Sicut *G. longula* Krempelh., sed lirellis longioribus (20 mm) et excipulo crenulato differt.
>
> *Etymology:* from the Latin *longus*, long, a reference to the long lirellae.

Thallus stramineous, yellowish brown, unevenly thickened, cracked, delimited by thin black hypothallus. **Ascomata** lirelline, 0.5–20 mm long, 0.1 mm broad, black, simple to irregularly branched, flexuose, immersed, scattered, terminally obtuse. **Disc** white pruinose. **Exciple** present at the base, completely carbonised, convergent, covered by a thalline exciple to the top, crenate at the outer side. **Epithecium** hyaline, thin.

Hymenium hyaline, clear, 121–130 μm high and 84–105 μm broad, I-. **Hypothecium** hyaline, thin. **Paraphyses** simple, long, thin. **Asci** 6–8 sporate, 110–120 x 6–8 μm. **Ascospores** 12–17-transeptate, narrow ellipsoidal, 76–88 x 4–8 μm, I + blue.

Chemistry—Thallus K+ yellow, C-, KC-, P+ yellow; UV-; stictic and constictic acids present.

Specimens examined—**Andaman Islands:** Tugapur Range, Pather Tikri, *MB. Nagarkar & PG. Patwardhan* 85.2600, 85.2631, 85.2715 (AMH); South Andaman, Shol Bay, near Wright Myo, *PG. Patwardhan & MB. Nagarkar* 86.696, 86.717 (AMH).

Remarks—*Graphis longissimea* is very similar to *G. longula* Krempelh., which is distinguished from the present species in having much shorter ascomata with deeply striate exciples.

Graphis palmicola Makhija & Adaw., *sp. nov.* **Figure 9**

Type—**India**, Nicobar Islands, Katchal, Beach forest, on coconut tree, 30.12.1986, *P.K. Sethy & P.G. Patwardhan 86.820;* holotype: AMH.

Similis *G. assimilis* Nyl., sed acidum deficience et ascosporis minoribus differt.

Etymology: from the Latin *Palma*, a palm tree and *cola*, exists, growing on palm tree.

Thallus grayish white, smooth, delimited by thin, black hypothallus. **Ascomata** lirelline, 1–6 mm long, 0.1–0.2 mm broad, black, almost always simple to rarely sparsely branched, emergent, scattered, terminally acute to obtuse. **Disc** broad, reddish-black, epruinose. **Exciple** present at the base, entire, completely carbonised, convergent, covered by a thalline exciple to the top, studded with crystals. **Epithecium** hyaline, thin. **Hymenium** hyaline, clear to sometimes inspersed with crystals, 120–150 μm high and 170–200 μm broad, I-. **Hypothecium** hyaline or yellowish orange, thin. **Paraphyses** simple, long, thin. **Asci** 4–6 sporate, 70–90 x 10–12 μm. **Ascospores** 4–12-transeptate, ellipsoidal, 21–29 x 4–8 μm, I + blue.

Chemistry—Thallus K-, C-, KC-, P-; UV-; no lichen substances present.

Specimen examined—**Nicobar Islands:** Katchal, *PK. Sethy & PG. Patwardhan* 86.821 (AMH).

Remarks—The morphology of the ascomata and general appearance of the new species resemble those of *G. assimilis* Nyl. but this species has a black disc, larger ascospores, 23–40 (–54) μm long, and contains norstictic acid. The morphologically similar *G. sauroidea* Leighton is distinguished from the new species by the larger ascospores, 45–60 x 10–14 μm, compared to 21–29 x 4–8 μm in *G. plamicola.*

Graphis sitapurensis Makhija & Adaw., *sp. nov.* **Figure 10**

Type—**India**, Andaman Islands, North Andaman, Diglipur Range, Sitapur, in moist deciduous forest, 2.1.1986, *P.K. Sethy & P.G. Patwardha, 86.145;* holotype: AMH.

Similis *G. subassimilis* Müll. Arg., sed ascosporis majoribus et lirellae immersae differt.

Etymology: from the Latin *ensis*, place of origin, and Sitapur, the type locality.

Thallus pale ashy gray, rough, thin, cracked, unevenly thickened. **Ascomata** lirelline, 1–5 (–7) mm long, simple to irregularly branched, black, scattered, immersed, irregular, flexuose, terminally acute to obtuse. **Disc** narrow to moderately broad, black, covered by white pruina. **Exciple** present below, entire, rarely apically carbonised but mostly laterally carbonised, convergent, covered by a thalline exciple up to half the height of the lirellae. **Epithecium** thin, hyaline. **Hymenium** hyaline, clear, 84–88 μm high and 105–126 μm broad, I-. **Hypothecium** thin, pale yellowish brown. **Paraphyses** simple, long, thick, unbranched. **Asci** 2–8 sporate, 125–130x 12–14 μm. **Ascospores** 13–17-transeptate, ellipsoidal, 63–84 x 4–8 μm, I+ blue.

Chemistry—Thallus K+ yellow to red, C-, KC-, P-; UV-; constictic and stictic acids present.

Remarks—In respect of the exciple characters and chemistry, *Graphis sitapurenis* is very similar to *Graphis subassimilis* Müll. Arg., from Indonesia, which, however, differs from the new species in having emergent lirellae and smaller ascospores, 60–68 x 7–8 μm.

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We acknowledge with thanks the late Dr. Mason Hale for his help in providing data on the *Graphidaceae* in the form of literature and making available to us his results from the re-examination of type and authentic specimens, and photographs of several taxa. We are grateful to Dr. Alan Archer, National Herbarium of New South Wales, Australia and Dr. André Aptroot, Centraalbureau voor Schimmelcultures, The Netherlands for their valuable comments on the manuscript. We are also highly grateful to Dr. Bettina Staiger for providing literature and to the Department of Science and Technology, Government of India, New Delhi for the financial support.

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The status of the genus *Scoliolegnia* Dick (*Saprolegniales*, Peronosporomycetes) with a new species from Argentina

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Abstract - *Scoliolegnia hypogyna* sp. nov. is described from dead unidentified species of Collembola in a freshwater habitat, located at Iguazú National Park, in Misiones province (Argentina). Distinguishing characteristics of *Sc. hypogyna* are the production of densely papillate oogonia, hypogynous antheridial cells and the absence of antheridial branches on the majority of the oogonia; the antheridial branches, when present, are monoclinous, diclinous or closely monoclinous; oospores are distinctively subcentric, 1-3(-6) per oogonium. The species is illustrated and compared with other species of the genus, and a key to the known *Scoliolegnia* species is included.

Key words - Peronosporomycota, *Straminipila,* systematics

Introduction

The genus *Scoliolegnia* was established for three species by Dick (1969). Seymour (1970) did not recognize *Scoliolegnia*, and Johnson et al. (2002) maintain a very broad generic concept for *Saprolegnia* which includes *Scoliolegnia*. Mil'ko (1979) formally transferred *Scoliolegnia* to *Saprolegnia*. Nevertheless, Dick (2001) and Spencer et al. (2002) retain *Scoliolegnia* on the basis of both morphology and molecular biology. We here formally reinstate the genus *Scoliolegnia*. The morphological differences between *Scoliolegnia* and *Saprolegnia* are summarized in Table 1. Molecular biology, based on *Scoliolegnia asterophora* (de Bary) M. W. Dick, *Sc. subeccentrica* M. W. Dick and *Sc. blelhamensis* M. W. Dick has indicated that *Scoliolegnia* and *Protoachlya* (*sensu* Dick 1973; see also Dick et al. 1999 and Spencer et al. 2002) are sister groups to *Saprolegnia sensu stricto*. Only two other taxa have subsequently been assigned to *Scoliolegnia*: *Sc. depauperata nomen nudum* (Dick 1971), now shown to be a form of *Pythiosis cymosa* de Bary with particularly papillate oogonia (Spencer et al. 2002) and *Sc. centrica* Khulbe (Khulbe 1983).

Most isolations of species in the genus *Scoliolegnia* have been from wet soil with high organic content and low pH. Only the type species (*Sc. asterophora*) is widely distributed and this species has also been reported from animal substrata as dead fish (Seymour 1970). This is the first report for a member of this genus from South

America and is noteworthy as being from a subtropical provenance, obtained by baiting with an animal substratum. During a survey of zoosporic organisms occurring in freshwater habitats from Misiones Province (Argentina), the authors found a species belonging to the genus *Scoliolegnia* with distinctive features separating it from other species in the genus. It is here named *S. hypogyna* Steciow, López Lastra & Dick *(Saprolegniales, Straminipila).* It was collected at Iguazú National Park, a protected area of the Paranense phytogeographic province (Cabrera & Willink 1973), which is one of the richest natural areas in Argentina on account of its biodiversity. It is located at the Northeast of Argentina. This is the first report of zoosporic organisms from this subtropical Argentine Province. Other recent isolations of zoosporic fungi have also been made by Buenos Aires and Tierra del Fuego Provinces (López Lastra et al. 1999, Steciow 2002, Steciow & Elíades 2002 a,b).

Material and Methods

Collection of aquatic insects was carried out in Misiones Province, Argentina, during May 2002. The collection site was "Bañado Ibicui" (25° 42´11" S latitude and 54° 20´46" W latitude) at Iguazú National Park. The insects were sampled using aquatic insect nets (Bioquip ®) and metallic sieves. Insects were transferred to plastic white pans and picked out with plastic pipettes, placed in plastic jars (100 cc) and kept in a cooler with ice for transfer to the laboratory. Insects were periodically removed. A collembolan was found dead and was covered with mycelia 24 hours later. The scarce material available and the rapidly growing fungus made it impossible to identify the host to species.

Single hyphal tips were separated, distributed in water culture in sterilized Petri dishes containing several halves of hemp seeds (*Cannabis sativa*), and incubated at room temperature (15--20 C). After growth of the fungus on the seeds a single hypha or spore was isolated and transferred to cornmeal agar medium to obtain an axenic culture. After 3-4 d, a block of agar from the edge of each colony was cut off and placed in sterilized Petri dishes containing distilled water. Hemp seed halves were added to obtain sister colonies. After the colony had grown out and reproductive structures formed, measurements and observations were made using an Olympus BX 40 microscope (Olympus Optical Co., Ltd, Tokyo, Japan) equipped with phase contrast optics. Ranges of colony diameters, oogonial diameters, numbers of oospores per oogonium, and oospore diameters were determined from 50 counts of each of 3 replicates. The type specimen of *Scoliolegnia hypogyna* is deposited in the mycological herbarium of Spegazzini Institute (LPS 45857); its culture collection is N° 775 (CLPS).

Figs. 1-9. *Scoliolegnia hypogyna.* **Fig. 1.** Aspect of mycelium with papillate oogonia develop in water cultures. **Fig. 2.** Terminal short clavate zoosporangium with characteristic papilla. **Fig. 3.** Zoosporangia showing zoospores inside before the liberation. **Fig. 4**. Closely monoclinous antheridial branches on oogonium. **Fig. 5.** Papillate oogonia with subcentric oospores inside. **Figs. 6,8,9.** Detail of oogonium with papillate, crenulate and wavy oogonial wall with characteristic hypogynous antheridial cell. **Figs. 7.** Apiculate oogonium borne on short oogonial stalk. Bars = 50 μm.

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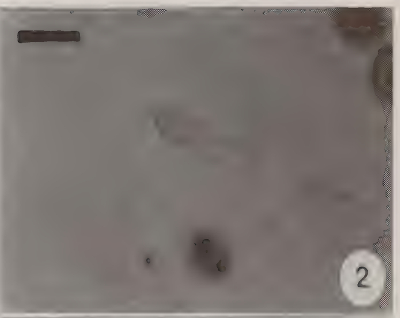
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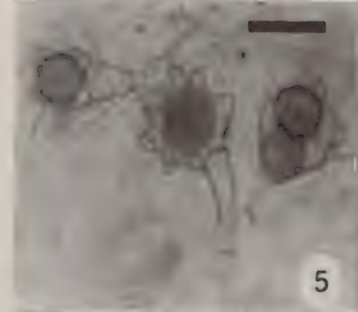
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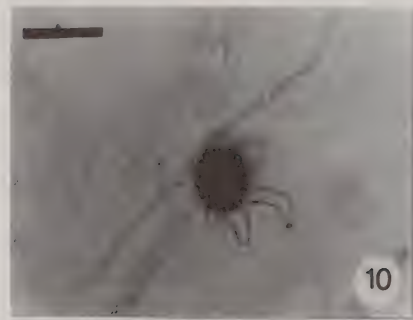
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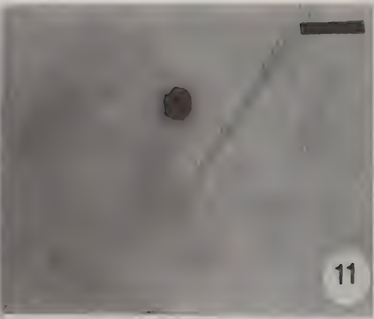
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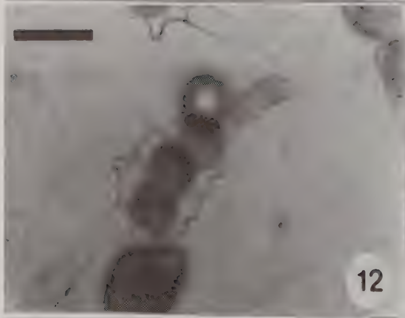
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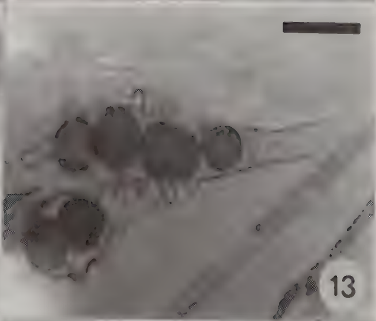
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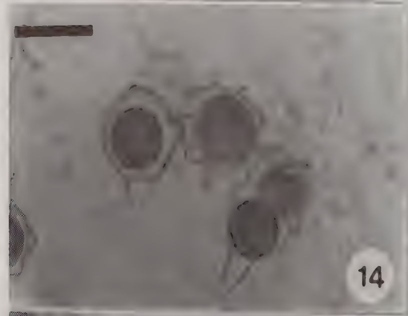
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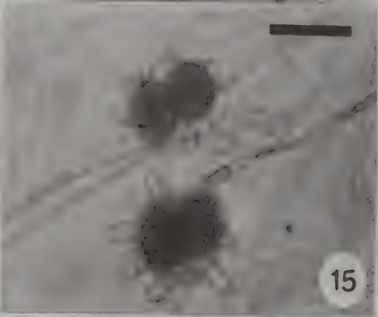
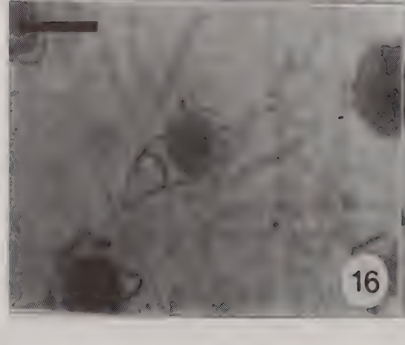
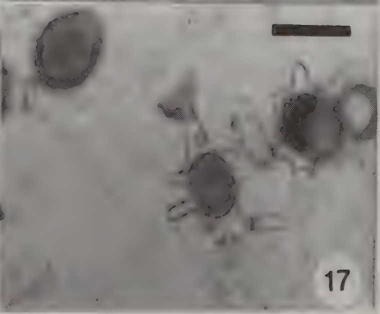

15


16


17

Taxonomy

Scoliolegnia hypogyna Steciow, López Lastra & Dick, **sp. nov.** **Figs 1-17**

Hyphae vegetativae delicatae, flaccidae, flexuosae et ramosae, pleraque 18-40 µm late ad basim. Cultura in seminibus Cannabis sativae L. circa 2-3 cm diam. Zoosporangia copiosa in culturis juvenilibus, clavata, fusiformia vel filiformia, (85) 100-300 (360) X (7) 15-25 µm longa. Ejecto sporarum pro genus typica, zoospori incystatis globosi 9-13 µm. Gemmae plures. Oogonia copiosa, pyriformia, sphaerica, naviculata vel doliiformia, rarissimo apiculata, (27) 36-50 (58) µm diam. Oogonia parie tenui, sine foveis, papillosa; ramulus lateralibus, terminalibus vel intercalaribus provenientia, (9) 14-638 (1170) µm. Oospori 1-3 (6) per oogonium, subcentrici, (17) 26-45 (50) µm diam. Antheridia plerumque desunt. Ramulus antheridialis, ramosus, monoclina, diclina et circa monoclina.

Etymology: in reference to the characteristic hypogynous antheridial cell.

Monoecious. **Mycelium** delicate, hyphae often flaccid and flexuous, 18-40 µm at the base; 2-wk-old hemp seed colony, 2-3 cm diam. **Zoosporangia** formed in young cultures; clavate, fusiform or filiform, sometimes pyriform, straight, bent or sinusoid; proliferating internally, or renewed sympodially or in a basipetalous and cymose fashion; usually short, with broad dehiscence papilla, (85) 100-300 (360) X (7) 15-25 µm. **Zoospores** dimorphic; discharge and behavior saprolegnoid; *primary spore cysts* 9-13 µm diam. **Gemmae** sparse; variable in shape, but generally papillate or provided with cylindrical protuberances; lateral, terminal or intercalary; single or catenulate; functioning as zoosporangia. **Oogonia** very abundant; lateral, occasionally terminal, often intercalary, single or catenulate; pyriform, spherical or oval, seldom naviculate, rarely apiculate or dolioform when intercalary; (27) 36-50 (58) µm diam. exclusive of wall ornamentations. **Oogonial wall** unpitted; densely papillate, with papillae variable in shape and size, or with papillae and cylindrical or elongate-papillate projections, straight or curved; sometimes wavy or crenulate, very rarely smooth. **Oogonial stalks** (9) 14-638 (1170) µm in length; short or long, tapering toward the base; straight or bent, rarely curved, branched or unbranched. **Oospores** subcentric; spherical or ellipsoid; 1-3 (6) per oogonium, filling or not filling the oogonium; (17) 26-45 (50) µm diam.; germination not observed. **Antheridial branches** absent; when present, monoclinous, diclinous or closely monoclinous, unbranched or very sparingly branched; persistent. **Antheridial cells** simple, mainly hypogynous, laterally appressed when arising from antheridial branches; persistent; fertilization tubes present or absent, persistent.

Holotype: **ARGENTINA**, **Misiones Province**: Iguazú National Park, Bañado Ibicui, on dead unidentified species of Collembola, 21 May 02, *C. López Lastra* (LPS 45857); culture collection (CLPS 775).

Figs. 10-17. *Scoliolegnia hypogyna.* **Fig. 10.** Papillate intercalary oogonia with different papillae in form and size. **Fig. 11.** Monoclinous antheridial branch. **Fig. 12-13.** Two terminal naviculate oogonia. **Fig. 14.** Naviculate, pyriform and oval oogonia, papillate, crenulate and wavy. **Figs. 15-17.** Different types of oogonia, some of them densely ornamentated with papillae and long cylindrical projections. Bars = 50 µm.

Discussion

Generic concepts: morphology and molecular biology

With respect to evolution within the *Saprolegniaceae* (and between *Saprolegnia* and *Scoliolegnia* in particular) the selection in the past of one, or at the most very few, characters was deemed to be sufficient to define and diagnose genera throughout the family and such diagnoses have been used in most classifications of the *Saprolegniaceae,* including those of Powell & Blackwell (1998) and Johnson et al. (2002). Such broadly circumscribed genera have now been shown to be inconsistent with monophyletic clades determined by molecular biological data (Dick et al. 1999, Riethmüller et al. 1999, Spencer et al. 2002, Göker et al. 2003). The asexual characters of mode of zoospore discharge and kind of zoosporangial renewal are too widely occurring in different clades to be considered single generic diagnostics: these are characters that have been only gradually modified in evolving clades after the nodal molecular biological event determining the clade. *Saprolegnia sensu lato* and *Achlya sensu lato*, as treated by Johnson et al. (2002) are not monophyletic and the diagnostic features for these *sensu lato* generic concepts should no longer be used (Dick et al. 1999, Spencer et al. 2002).

Monophyletic genera should now be defined using as many characters states as possible, no one of which will serve, on its own, to define the genus (Dick 2001: 91). The genus *Scoliolegnia* was erected on such a suite of characters (Table 1; Dick 1969) and *Scoliolegnia* has now been shown to be a monophyletic line divergent from *Saprolegnia sensu stricto* and sister to both *Saprolegnia sensu stricto* and *Achlya mucronata* (in the `protoachlya' group of Dick 1973) (Spencer et al. 2002). Unfortunately, it has not been possible to obtain and process DNA material from either *Sc. centrica* nor the present isolate. There are insufficient isolations of *Scoliolegnia* species world-wide to determine the extent of intraspecific variation in any species of the genus; it is therefore appropriate to describe the present species isolate as a new species, with the proviso that, in time, it might be possible to recognize a species complex similar to that proposed for *Saprolegnia ferax* Gruith. (Johnson et al. 2002).

Species criteria

The comparative structure of the living, mature, resting, peronosporomycete oospore has been described in detail by Dick (2001). In some clades a morphological feature is uniform and can form part of the diagnosis of the clade, but in other comparable clades the same morphological feature is variable and cannot be so used. This holds for the situation with the internal cytoplasmic reorganization that takes place during the production of the mature oospore. In *Scoliolegnia* the oospore internal structure is not fixed throughout the clade, and subeccentric oospores can coexist with subeccentric and centric states (note the qualification regarding the distinction between subcentric and centric states given in Dick 1969).

Comparable variation in internal oospore structure is found in the genus *Apodachlya (Leptomitales)*. In *Newbya*, *Achlya sensu stricto* and *Pythium sensu stricto* the internal structure of the oospore is stable and can form part of the genus diagnosis.

From Table 1 it is clear that *Sc. hypogyna* is correctly placed in the genus *Scoliolegnia*, and from Table 2 it is equally clear that *Sc. hypogyna* differs significantly from

Table 1. Morphological characters of *Saprolegnia* and *Scoliolegnia* genera.

	Saprolegnia	*Scoliolegnia*
Mycelium	Usually stiff, stout (up to 40 μm diam. or more) and straight in young culture	Flacid and flexuous even in young cultures
Zoosporangia	Usually abundant; elongate, cylindrical, less frequently fusiform or clavate	Abundant or rare; elongate, clavate or cylindrical, never naviculate (cf. *Brevilegnia*) or fusiform
Zoosporangial renewal	Almost always by internal proliferation	By basipetal succession, internal proliferation or cymose renewal when zoosporangia abundant, by internal proliferation when zoosporangial production rare
Zoospore discharge	Saprolegnioid	Saprolegnioid (never brevilegnioid - cf. *B. bispora*)
Gemmae	Often present; form various, often spherical, occasionally fusiform	Rare or occasional, fusiform
Oogonia	Usually spherical, occasionally broadly clavate; fusiform if intercalary. Smooth walled. Often pitted	Usually spherical, irregularly fusiform if intercalary. Always more or less papillate; papillae broadly rounded at apex; if papillae sparse, then often of variable length. Never pitted
Antheridia	Usually present, antheridial branch origins various (hypogynous in one species)	Present or absent, branch origins usually closely monoclinous, semihypogynous (hypogynous in one species)
Oospores	Large, usually numerous per oogonium, modal value 2, usually more	Large, usually 1 per oogonium, rarely 2
Ooplast	Fluid with very numerous granules in Brownian motion	Gel-like with relatively few granules, granules often clumped, not in Brownian motion
Oospores lipid globules	Of more or less uniform diameter, often in 2-5 \`shells' , completely surrounding the ooplast, giving centric or subcentric configuration	Often of widely divergent diameters, usually forming 1-2 \`shells', often incomplete so that the ooplast may be adjacent to the ooospore plasmamembrane (and thus apparently to the oospore cell wall)

Table 2. Comparison of morphological characters of the described *Scoliolegnia* species (according to Khulbe 2001, Johnson et al. 2002).

	Oospore	Zoosporangia (μm) & zoosporangial renewal	Oogonial wall & oogonial shape	Oogonia (μm)	Oospores number/ Oospores (μm)	Anth. branches	Gemmae
Sc. asterophora	Subcentric	120-821 X 12-43 clavate or fusiform renewed internally	Densely papillate or provided with papillae and tuberculate projections. Unpitted Spherical, subspherical or oval, infreq. napiform or obpyriform	(25)42-56(78)	1-2(6)/ (17)26-33(44)	Androgynous, rarely monoclinous, very rarely diclinous	Present Sparse; Clavate or irregular
Sc. blelhamensis	Subeccentric	50-584 X 15-29 clavate or cylindrical renewed internally	Thin, densely or sparsely papillate,occasionally provided with cylindrical or elongated- papillate projections, or smooth or nearly smooth. Unpitted. Spherical, subspherical, oval or dolioform (intercalary)	(23)43-66(97)	1-3(12)/ (16) 23-32(41)	Lacking	Lacking
Sc. centrica	Centric	(sizes not mentioned in detail in its original description) elongate, occasionally curved, cylindrical, clavate; cymose, rarely internal proliferation	Wall irregularly papillate, papillae many. Unpitted or pitted at the antheridial contact. Spherical or obpyriform, occasionally subglobose or slightly irregular.	30-60	1-2/ 20-30	Moderately abundant. Androgynous or semihypogynous	Present, Abundant, Various in shape
Sc. hypogyna	Subcentric	(85)100-300(360)X(7)15-25 clavate, fusiform or filiform renewed internally, sympodially or in a basipetalous and cymose fashion	Densely papillate or provided with papillae and tuberculate projections; rarely wavy or crenulate, very rarely smooth. Unpittted. Pyriform, spherical or oval, seldom naviculate, rarely apiculate or dolioform (intercalary).	(27)36-50(58)	1-3(6)/ (17)26-45(50)	Freq. lacking (anth. cell hypogynous). Monoclinous, diclinous or closely monoclinous	Present Sparse; Papillate, or with cylindrical protuberances
Sc.subeccentrica	Subeccentric	116-883 X 14-33, cylindrical, clavate or fusiform, often curved or slightly irregular proliferating internally or renewed sympodially or in a basipetalous fashion	Thin, densely provided with papillae, or with cylindrical, curved, irregular, or bifurcate ornamentations rounded at apex. Unpitted. Spherical, subspherical, ellipsoidal or dolioform (intercalary)	(28)39-57(76)	1-2(4) (16)23-36(52)	Sparsely, androgynous or monoclinous	Lacking

previously described species; most particularly in its hypogynous antheridium and in the irregular lengths of its oogonial papillae, which are comparable with those of *Sc. blelhamensis*, a species lacking antheridia. It is difficult to assess *Sc. centrica*, for which only two oogonia are figured (Khulbe 1983, 2001). This species also appears to have irregular oogonial papillae, it has antheridia but no hypogynous antheridia. *Scoliolegnia* has a range of patterns of zoosporangial renewal, although zoosporangial production and renewal may be rare. *Sc. subeccentrica* shows abundant production with basipetal renewal while in *Sc. blelhamensis* production is restricted, but proliferation, when it occurs, is internal. The present species shares sufficient characters with the species described by Dick (1969) and is sufficiently distinct with respect to its antheridial characters to justify the erection of a new species.

Key to *Scoliolegnia* species

1. Oospores centric or subcentric, mature oospores with lipid globules of more or less uniform diameter, completely surrounding the ooplast **2**

- Oospores subeccentric, mature oospores with lipid globules of very variable diameter, not completely surrounding the ooplast **3**

2. Oospores centric, lipid globules forming a single layer or `shell' around the ooplast; mean oospore diameter 25 μm [zoospore renewal cymose; modal number of oospores per oogonium 1] .... **Sc. centrica**

- Oospores subcentric, lipid globules forming one or more complete `shells' together with one or more incomplete `shells' around the ooplast; mean oospore diameter > 26 μm [zoosporangial renewal various; modal number of oospores per oogonium 1 or more] **4**

3. Modal number of oospores per oogonium 2; mean oospore diameter < 30 μm; zoosporangia rare, mostly 100-200 μm long; zoosporangial renewal internal; antheridia absent .... **Sc. blelhamensis**

- Modal number of oospores per oogonium 1; mean oospore diameter > 33 μm; zoosporangia abundant, mostly 300-600 μm long; zoosporangial renewal usually basipetal; antheridia often absent, when present single, not arising from a cluster of hyphae, closely monoclinous .... **Sc. subeccentrica**

4. Modal number of oospores per oogonium 1; lipid globules forming 2-3 complete `shells' together with one on more incomplete `shells' around the ooplast; zoosporangia rare, 100-300 μm long; antheridia usually present, antheridial branches often arising from a cluster of hyphae below the oogonium .... **Sc. asterophora**

- Modal number of oospores 2; lipid globules forming 1-2 complete `shells' together with one or more incomplete `shells' around the ooplast; zoosporangia abundant, 100-300 μm long; antheridia often absent, when present usually hypogynous .. .. **Sc. hypogyna**

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Seven rust species recorded as new to Turkey

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Abstract— Seven species of rust fungi are reported for the first time from Turkey: *Coleosporium euphrasiae* on *Euphrasia hirtella, Coleosporium telekiae* on *Telekia speciosa*, *Phragmidium acuminatum* on *Rubus* sp., *Puccinia smilacis* on *Smilax excelsa*, *Uredo daphnicola* on *Daphne oleoides*, *Uromyces baeumlerianus* on *Melilotus neopolitana*, and *Uromyces sophorae-flavescentis* on *Sophora jaubertii*. The microscopical features of these fungi are described.

Key words—new records, parasites, *Uredinales*

Introduction

There has been some research on Turkish microfungi (e.g., Bremer et al. 1947, 1952; Karel 1958; Gobelez 1962; Henderson 1964; Bahcecioglu & Isıloglu 1995; Bahcecioglu & Yildiz 1996, 2004; Bahcecioglu 1997, 1998, 2001; Bahcecioglu & Gjærum 2003, 2004), but the knowledge of the microfungal flora of Turkey is still very scanty and at an early stage of development. The present study was carried out in Ordu province where is found to the northeastern of Turkey, which has a rich vascular plant flora.

Materials and Methods

The material presented here was collected in the years 2002-2003 in Ordu province. Spores were mounted in lactophenol. The host names follow the Flora of Turkey and Aegean Islands by Davis (1965 – 1985) and Davis et al. (1988). After identification, the rusts were deposited in the herbarium of Inönü University.

Coleosporium euphrasiae (Schumacher) G.Winter. — Rabenhorst's Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz., Zweite Auflage 1(1): 246, 1884.

On *Euphrasia hirtella* Jordan ex Reuter (*Scrophulariaceae*)
Ordu. 10 km from Unye to Caybası, 30 m, 19. Sept. 2002, S. Kabaktepe 2095, II+III.

Uredinia amphigenous and on stems, pale yellow coloured. Urediniospores ovoid, globoid, (16)18-29×13-18 μm, wall 1-2 μm, densely verrucose. Telia amphigenous and on stems, minute, rounded, orange coloured. Teliospores cylindric, orange-yellow, 68-105×15-24 μm, wall hyaline and 10-15 μm thick at the apex, smooth.

C. euphrasiae is a new rust species for Turkey. Some *Coleosporium* species have been reported several times from Turkey. Bremer et al. (1952) reported *C. campanulae* (Pers.) Lév. on *Campanula* spp. and *C. inulae* Rabenh. on *Aster* spp. Gobelez (1962) reported *C. inulae* on *Chrysophtalmum dichotomum* Boiss. & Heldr. and Henderson (1964) reported *Coleosporium tussilaginis* (Pers.) Lév. on *Senecio orientalis* Willd., *Tussilago farfara* L., *Pedicularis comosa* L. and *Rhinanthus minor* L.

C. euphrasiae has been reported on *Euphrasia hirtella* from France. It is quite common on many *Euphrasia* spp. in Europe, in Asia known from Siberia and Japan. Its main host genus is *Euphrasia* but this rust also can be on *Rhinanthus* (Gäuman, 1959).

Coleosporium telekiae Thuemen. – Fungi Austriaci Exsiccati no. 850, 1873.

On *Telekia speciosa* (Schreber) Baumg. (*Asteraceae*).

Ordu. Aybastı. Alanyurt village, 1250 m, 23. July 2002, S. Kabaktepe 1483, II+III.

Uredinia amphigenous, rounded, scattered, yellow-orange coloured. Urediniospores ellipsoid, ovoid, 18-28×16-22 μm, wall 1-1.5 μm thick, hyaline, verrucose. Telia amphigenous, scattered or in groups, rounded, 0.4-0.6 mm in diameter, pale yellow. Teliospores cylindric, 80-130×19-25 μm, wall hyaline and 20-25 μm thick at the apex, smooth, pale orange.

C. telekiae is a new rust species for Turkey. It has been reported on *Telekia speciosa* from Slovakia, Austria, Caucasus and the Balkan area. *Telekia speciosa* is the only host for this rust.

Phragmidium acuminatum (Fries) Cooke. –Handb. Brit. Fungi, p.490,1871.

Syn. *Aregma acuminata* Fr. -Obs. Mycol. 1, 226, 1815.

On *Rubus* spp. (*Rosaceae*).

Ordu. Mesudiye Mahmudiye village, 1150 m, 21. Sept. 2002, S. Kabaktepe 2354, III.

Telia hypophyllous, scattered or in groups, pulverulent, black. Teliospores cylindric or fusiform, 4-9 celled, 52-110×25-32 μm, wall 3-4 μm, densely verrucose, chestnut-brown, each cell with 3-4 pores, pedicels persistent, hyaline, up to 160 μm long, wider at the base.

Ph. acuminatum is a new rust species for Turkey. *Ph. rubi* (Pers.) G. Winter. has been reported on *Rubus* spp. by Karel (1958) and *Ph. violaceum* (Schultz.) G. Winter. has been reported on *Rubus* spp. by Bremer at al. (1947), Karel (1958), Bahcecioglu & Yildiz (1996) from Turkey. *Ph. acuminatum* is widespread in Europe. Reported scattered from Caucasus to China.

Puccinia smilacis Schwein. – Schr. naturf. Ges. Leipzig 1: 72 (1822).

On *Smilax excelsa* L. (*Liliaceae*).

Ordu. Persembe, Yumrutas village, 20 m, 27. July 2002, S. Kabaktepe 1406, II+III.

Uredinia hypophyllous, scattered or in groups, brown. Urediniospores globoid, ellipsoid, 21-33×16-20 μm, wall 1.5-3 μm, yellow, echinulate, each cell with 2-3 equatorial pores. Telia hypophyllous, minute, black coloured. Teliospores long ellipsoid or ellipsoid, rounded above and below or attenuate, 30-51×17-23 μm, wall 1-2.5 μm, smooth, apically thickened to 5-10 μm, dark brown, constricted at septa, pedicels persistent, yellowish, as long as spores.

P. smilacis is a new rust species for Turkey. It has been reported from the Caucasus area, India, China and from the Americas. *Smilax excelsa* is reported as a host from Caucasus.

Ale-Agha (1989) reported *P. smilacis-persicae* Ale-Alga on *S. excelsa* in Iran. The teliospores of this species are verruculose while smooth in *P. smilacis*

Uredo daphnicola Dietel. – Saccardo's Syll. fung. XIV: 400, 1898.

Syn: *Melampsora daphnicola* (Dietel) Jörst. –Skr. Vidensk.-Akad, Oslo 1, 9: 55, 1934. (II).

On *Daphne oleoides* Schreber (*Thymelaeaceae*).

Ordu. 25 km from Fatsa to Korgan, 1120 m, 25. July 2002, S. Kabaktepe 1589, II.

Uredinia hypophyllous, rounded, 1.5 mm in diameter, covered by the epidermis, brown. Urediniospores globoid, ellipsoid, ovoid, 18-26×15-21 μm, wall 1.5-2.5 μm, hyaline, densely verrucose. Paraphyses capitate, up to 100 μm long, 5-8 μm wide at the base and thickened 20-30 μm at the apex.

Uredo seems to be a new rust genus in Turkey. *U. daphnicola* is a new species for Turkey. It has been reported from Kamchatka, China, Japan, and the Kuriles.

Uromyces baeumlerianus Bubák. -Hedwigia 47: 363, 1908.

On *Melilotus neopolitana* Ten. (*Fabaceae*).

Ordu. Unye Tekkiraz village, 80 m, 1. Aug. 2003, S. Kabaktepe 2829, II+III.

Uredinia hypophyllous, scattered or in groups, brown. Urediniospores rounded, ellipsoid, 20-33×17-22 μm, wall 1-2 μm, pale brown, echinulate, with 2-4 equatorial pores. Telia similar to uredinia but dark coloured. Teliospores globoid, ellipsoid, 20-28×17-22 μm, wall 1-2 μm, brown, verrucose, at apex with a minute hyaline papilla, pedicels hyaline, short, deciduous.

U. baeumlerianus is a new rust species for Turkey. It has been reported from Latvia, Portugal to Bulgaria, Ukrainas, Azerbaijan and Armenia. It is also reported from Morocco, Egypt, Iran, India, China, and the Ryukyu Islands.

Uromyces sophorae-flavescentis Kusano. – Saccardo's Syll. fung. XVII: 254; XX: 1091, 1904.

On *Sophora jaubertii* Spach (*Fabaceae*).

Ordu. 23 km from Catalpınar to Kabatas, 700 m, 24.July 2002, Ş. Kabaktepe 1537, II+III.

Uredinia hypophyllous scattered or in groups, pulverulent, covered by the epidermis, brown. Urediniospores ovoid, globoid or subgloboid, 20-28×20-26 μm, wall, 1.5-2.5 μm, dark yellow, echinulate, with 4-7 scattered pores. Telia similar to uredinia but dark coloured. Teliospores ellipsoid, globoid, ovoid, 20-28×18-25 μm, wall 1-2 μm, dark brown, verrucose, at apex with small hyaline papilla, pedicels hyaline, short, deciduous.

U. sophorae-flavescentis is a new rust for Turkey. It has been reported from Siberia, China, Japan and Korea.

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Crepidotus crocophyllus includes *C. nephrodes*

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Abstract—Many species of the agaric genus *Crepidotus* are distinguished based on single, potentially variable morphological characters. Numerous collections of *Crepidotus* belonging to a species complex that includes *C. crocophyllus* and *C. nephrodes* were examined from Central and Eastern Europe and North America. Morphological observations were supplemented by phylogenetic analysis of nuclear ribosomal 28S DNA. Our results indicate that *C. crocophyllus* is a broadly-distributed temperate fungus with variable pigmentation. The fungus is re-described and a taxonomic discussion provided.

Key words—*Agaricales*, taxonomy

Introduction

Several collections of an interesting species of *Crepidotus* (Fr.) Staude (*Crepidotaceae, Agaricales*) made by one of us (SR) in Slovakia were identified as *C. crocophyllus* (Berk.) Sacc., although these collections were notably different in lamellae color from the description of Pilát (1948a). This prompted additional field observation of basidiomata development in specimens from Slovakia related to this taxon and the examination of numerous collections from North America and Eastern Europe. Published description of the North American *Crepidotus nephrodes* (Berk. & M. A. Curtis) Sacc. by Hesler & Smith (1965) describes it as very similar to *C. crocophyllus*, differing mainly in pigmentation of the lamellae—pallid in *C. nephrodes* and bright orange in *C. crocophyllus*. Previous mating intercompatibility studies between many North American isolates from *Crepidotus* subsection Fulvofibrillosi Hesler & Smith (Aime, 2004) showed that several morphological species placed here (mainly following Hesler

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[4] Mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.

& Smith, 1965), including *C. nephrodes*, were conspecific but the taxonomy of this group was not addressed in that work, and isolates of *C. crocophyllus* were not obtained for mating studies. This has led us to evaluate the relationship of *C. crocophyllus* and *C. nephrodes*, in North America and Europe, by examination of collections, sequencing data, field data of basidiomata development, and a re-evaluation of the phenotypic characters previously used to define taxa in this complex.

This paper provides: (1) a taxonomic revision of *Crepidotus crocophyllus*; (2) a discussion and an expanded description for this taxon; (3) a discussion of the morphological characters previously used to segregated species in this complex; (4) descriptions of basidiomata development in the field, and (5) a delimitation of the taxon supported by phylogenetic analysis.

Nomenclature and taxonomy

First to present a concise taxonomic and nomenclatural treatment of *Crepidotus* was Pilát (1948a) in the Czech edition of his monograph. Here he treated *C. crocophyllus*, *C. applanatus* var. *kuzyanus*, *C. fulvifibrillosus* and *C. dorsalis* as synonyms of *C. applanatus* var. *crocophyllus*. However, in the French edition of his monograph (Pilát, 1948b) the name *C. applanatus* var. *fulvifibrillosus* was used and only *C. fulvifibrillosus*, *C. applanatus* var. *kuzyanus* and *C. dorsalis* were listed in synonymy; the description was unchanged.

Originally (Pilát, 1940) the name *Crepidotus applanatus* var. *kuzyanus* Pilát was invalidly published (ICBN, Art. 32, 37). Several collections held at PRM (23481, 23482, 23483, 23484, 28616) were identified by Pilát under that name. He later 'renamed' those collections as *C. applanatus* var. *crocophyllus* (Pilát, 1948a) and/or *C. applanatus* var. *fulvifibrillosus*. (Pilát, 1948b).

Hesler & Smith (1965) in their monograph of North American members of *Crepidotus* distiguished two closely related taxa, *C. crocophyllus* and *C. nephrodes*. After studying type specimens they concluded that *C. dorsalis* was conspecific with *C. crocophyllus,* and that *C. fulvifibrillosus* was conspecific with their *C. nephrodes*.

Hesler & Smith's concept was followed by Lazebníček (1970) who treated Pilát's collections (originally labelled as *Crepidotus applanatus* var. *kuzyanus*) from the Eastern Carpathians as *C. nephrodes*. This was probably the reason he did not mention or comment on any of Pilát's names, such as *C. applanatus* var. *kuzyanus*, *C. applanatus* var. *crocophyllus* and *C. applanatus* var. *fulvifibrillosus*.

Senn-Irlet (1995), in her European monograph, accepted *C. crocophyllus* as an autonomous taxon and she listed in the synonymy *C. dorsalis, C. fulvifibrillosus, C. applanatus* var. *fulvifibrillosus* and *C. appalanatus* var. *crocophyllus*. She studied specimens collected by Lazebníček, but not those of Pilát. The identity of American taxa, including *C. nephrodes,* was not treated in that monograph.

Material and Methods

Material. Fresh material was examined immediately and the macroscopic structures recorded. Color designations follow Kornerup & Wanscher (1974). Microscopic structures were recorded from material rehydrated in 80% EtOH and water. Thin sections were mounted in 10% NH_4OH, 5% KOH, and/or Congo red and viewed under oil immersion. Microscopic measurements are approximated to within 0.75 μm and were estimated as 5-95 percentiles of 39 measurements per collection. Terminology of microscopic features follow Vellinga (1988). Designations for herbaria are from Holmgren & al. (1990).

Field studies. Our field observations took place on Sihot' Island, Podunajská nížina lowland (lat. 48°09′19″–48°08′33″, long. 17°01′00″–17°03′30″, 136.5–140 m, south-western Slovakia, city of Bratislava, municipal part Karlova Ves). Fruiting bodies growing on the upper surface of a fallen, decorticated trunk of *Negundo aceroides* were monitored, and growth and morphology recorded every second day over a one week period in June 1999.

Morphometric analysis. Delimitation of *Crepidotus crocophyllus* and *C. nephrodes* were based on Hesler & Smith (1965) and on Pilát's (1940, 1948a, 1948b) and Senn-Irlet (1995) delimitation of taxa related to *C. crocophyllus*. Specimens from Europe and the U. S. A. originally identified as *C. crocophyllus* and *C. nephrodes* were also considered. Additionally, comparative studies of various of the concepts in *Crepidotus* used in this work followed Hesler & Smith (1965).

Phylogenetic analysis. Nine species of *Crepidotus* were analyzed to represent the genotypic diversity in the genus, including North American samples of *C. crocophyllus* and *C. nephrodes,* a Slovak isolate of *C. crocophyllus,* and *C. malachius* the known sister-species to *C. nephrodes* (Aime, 2001). Sequences of the 28S ribosomal DNA (nLSU) were obtained from GenBank as accession numbers AF139946, AF205670, AF205674, AF205677, AF205679, AF205690, AF205707, AF367936, AF367939, and AF367958 (Aime, 2001, 2004; Moncalvo & al., 2002; Thorn & al., 2000). Two sequences from the genus *Simocybe* were selected as outgroups for rooting the tree, as this genus has been previously shown to be a sister genus to *Crepidotus* (Aime, 2001). Sequence alignments were constructed by eye in SE-AL ver. 2.0a11 (Rambaut, 1996-2002). The nLSU data matrix of 16 taxa and 892 characters was then exported to PAUP* 4.0b10 (Swofford, 2002) for analysis. Maximum parsimony (MP) analyses were conducted as heuristic searches with 100 random addition replicates and TBR branch swapping. Support for the branching topologies was evaluated by bootstrap analysis derived from 1,000 replicates with 10 random addition replicates each. Maximum likelihood (ML) analyses were conducted by the quartet puzzling method in PAUP* 4.0b10 with 10,000 puzzling steps.

Results

Field observations

Our field observation on Sihot' Island, Podunajská nížina lowland, started on 16 June 1999 and were continued until 20 June 1999. Gross size and changes in the color of lamellae and pileus surface of 19 basidiomata of *Crepidotus crocophyllus* growing on the upper side of wood of a fallen rotten trunk of *Negundo aceroides* were monitored every second day.

June 16: Basidiomata 0.3–1.1 × 0.4–2.6 cm, lamellae yellowish orange (4A8), melon (5A6) or melon with yellowish orange tint at the edge of the pileus; pileus surface cinnamon (6D6) to rust (6E8).

June 18: Basidiomata 1.6–2.4 × 1.8–3.9 cm, lamellae of all basidiomata corn (4B5) without any yellowish-orange or melon colouration. Colour of basidiomata not exposed to rain has not changed. Exposed basidiomata have lost their initial brownish fibrils, appearing cream (4A3). Two new basidiomata grew on the trunk: 0.8–0.9 × 1.1–1.7 cm, lamellae yellowish-orange (4A8) and pileus surface cinnamon (6D6).

June 20: Only five fruitbodies (of 19 previous) with distinct characters survived: 2–2.3 × 2.3–2.9 cm, colour of lamellae and pileus surface were unchanged. Lamellae of the remaining decaying basidiomata were honey yellow (5D6). Basidiomata that appeared 16–18 June had yellow ochre (5C7) lamellae, colour of pileus surface unchanging.

Phylogenetic analyses

Nine *Crepidotus* taxa were analyzed, representing a cross-section of the genetic variation already found within the genus in other studies (Aime, 2001). *Crepidotus nephrodes* and *C. crocophyllus* from North America and Slovakia form a single monophyletic lineage, sister to *C. malachius* (Berk. & M. A. Curtis) Sacc. (Fig. 1). A total of 892 equally-weighted characters were aligned across all bases. Of these, 71 were parsimony-informative and 773 were constant. The MP analyses produced a single most parsimonious solution of 204 steps with a CI of 0.696 and RI of 0.684. Both MP and ML analyses produced trees with identical branching topologies.

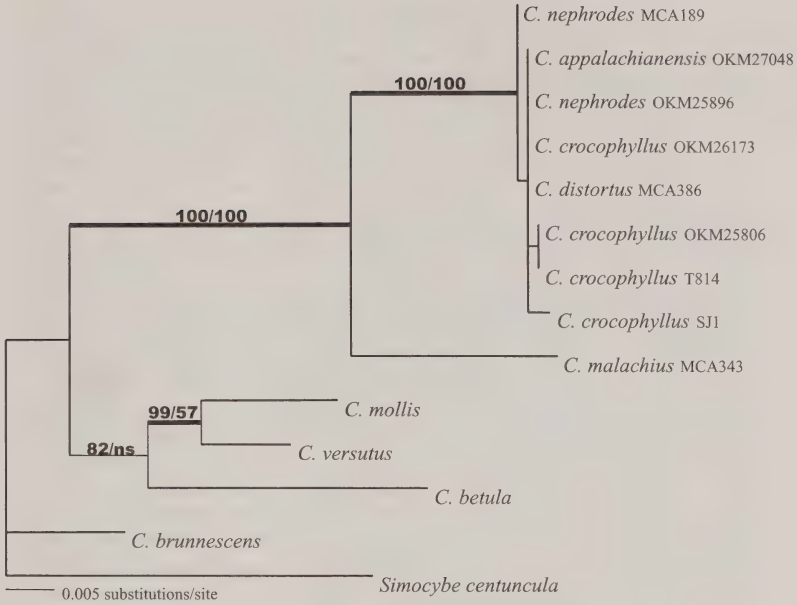
Taxonomy

Crepidotus crocophyllus (Berk.) Sacc., Syll. Fung. 5:886, 1887.

≡ *Agaricus crocophyllus* Berk., London J. Bot. 6:313, 1847.
≡ *Crepidotus applanatus* var. *crocophyllus* (Berk.) Pilát, Atlas Hub Evrop. 6: 33, 1948.
= *Agaricus nephrodes* Berk. & M.A. Curtis, Ann. Mag. Nat. Hist., ser. 2, 12:442, 1853.
≡ *Crepidotus nephrodes* (Berk. & M.A. Curtis) Sacc., Syll. Fung. 5:882, 1887.
= *Crepidotus fulvifibrillosus* Murrill, North Amer. Flora 10:153, 1917.
≡ *Crepidotus applanatus* var. *fulvifibrillosus* (Murrill) Pilát, Atlas Champ. Eur. 6: 35, 1948.
= *Agaricus dorsalis* Peck, Rep. (Annual) New York State Mus. Nat. Hist. 24: 69, 1972.
≡ *Crepidotus dorsalis* (Peck) Sacc., Syll. Fung. 5:883, 1887.

The description, based on fresh and herbarium specimens, expresses our taxonomic concept of the species and variability of its characters.

Pileus 7–78 × 5–55 mm, flabelliform, rounded flabelliform, spathuliform, reniform, conchate or irregularly circular, at first hemispherical, convex, soon plano-convex, later applanate, laterally or dorsally attached to the substratum, non-hygrophanous. **Margin of pileus** at first involute, soon inflexed, later straight, plane, smooth. **Pileus surface** at first squamulose, soon fibrillose, fibrils brownish orange (6C8), cinnamon (6D6), rust (6E8), or light yellow (4A4), at point of attachment tomentose and cream (4A3), maize (4A6), or butter yellow (4A7). **Pileipellis** a cutis composed of 4.5–7.5 µm thick, cylindrical, thin-walled, hyaline hyphae. Squamules formed by 6–19 µm thick, cylindrical, thin-walled, incrusted, hyaline to coloured, ascending hyphae. Their terminal cells are 7.5–18 × 41.5–97.5 µm, narrowly utriform, conical, cylindrical or


C. nephrodes MCA189
C. appalachianensis OKM27048
C. nephrodes OKM25896
C. crocophyllus OKM26173
C. distortus MCA386
C. crocophyllus OKM25806
C. crocophyllus T814
C. crocophyllus SJ1
C. malachius MCA343
C. mollis
C. versutus
C. betula
C. brunnescens
Simocybe centuncula
100/100
100/100
99/57
82/ns
0.005 substitutions/site

fusiform, at apex subcapitate or billed, thick-walled, without incrustations, coloured. **Pileus trama** up to 5 mm wide, thicker below point of attachment, whitish, composed of 7.5–14 µm thick, cylindrical, short-celled hyphae. **Lamellae** L = 10–32, l = 1–3, up to 6 mm wide, subventricose, ventricose, crowded, adnexed, narrowly adnate, at first yellowish orange (4A8), melon (5A6), apricot (5B6) or carrot orange (6B7), soon yellow ochre (5C7) or brownish orange (6C8), but also light yellow (4A4) or corn (4B5), later honey yellow (5D6) or cinnamon (6D6). Edges fimbriate, whitish. **Basidiospores** (4.5) 5–7 µm, globose to subglobose, baculate, yellowish. **Spore print** honey yellow (5D6). **Basidia** 6–7.5 × 22.5–30 µm, 4-spored, cylindrical or narrowly clavate, thin-walled. **Cheilocystidia** 28.5–57 × 6–9 µm, clavate, cylindrical, less flexuose, often narrowly lageniform, narrowly utriform or utriform, at apex capitate, subcapitate or very rarely branched, rarely septate, thin-walled, hyaline. **Clamp connections** present. **Stipe** only in very young fruitbodies recognisable, 1–1.5 × 1–2 mm, lateral and reduced, squamulose, brownish orange (6C8), soon absent.

Specimens studied — Slovakia: ZÁHORSKÁ NÍŽINA lowland, Brodské, boggy forest, on decaying trunk of Quercus sp., 6 June 1971, A. Dermek (BRA); Brodské, 8 May 1972, A. Dermek (BRA); Jakubov, Nature Reserve of Šmolzí (Jakubov Feld), flood-plain forest, 200 m, on rotten trunk of *Alnus?,* 24 Sept. 1993, P. Škubla (BRA); Moravský Svätý Ján, ca 4.7 km W from the St. Ján Krstiteľ church, flood-plain forest (Salicion albae), 153 m, on wood of fallen, rotten trunk of *Populus nigra,* 24 July 2001, V. Kučera & K. Janovicová (SLO). PODUNAJSKÁ NÍŽINA lowland, Bratislava – municipal part Devín, Sedláčkov ostrov Island, flood-plain forest, ca 135 m, on bark of fallen, decaying trunk of *Fraxinus* sp., 2 July 1997; on wood of fallen, decaying trunk of *Fraxinus* sp., 2 Sept. 1998; on wood of fallen, decaying trunk of *Negundo aceroides,* 6 Aug. 1998; on wood of fallen, rotten trunk of *Negundo aceroides,* 16 July 1999, (all specimens) S. Ripková (SLO); Bratislava – municipal part Karlova Ves, Sihoť Island, flood-plain forest, ca 135 m, on wood of fallen, decaying branch of *Fraxinus* sp., 7 Aug. 1997, 4 Sept. 1999; on wood of fallen, decaying trunk of *Fraxinus* sp., 11 Aug. 1997, 16 Oct. 1997; on wood of fallen, decaying branch of *Negundo aceroides,* 18 Aug. 1997, 22 Sept. 1998; on wood of fallen, decaying trunk of *Negundo aceroides,* 19 Aug. 1999; on wood of fallen, rotten trunk of *Negundo aceroides,* 23 Sept. 1997, 7 June 1999, 16 June 1999, 18 June 1999, 20 June 1999, 24 Aug. 1999, 21 July 1998; on wood of fallen, decaying trunk of *Populus* sp., 7 Oct. 1998, 9 June 1999, 7 Oct. 1999; on wood of fallen, rotten trunk of *Populus* sp., 24 Aug. 1999, 2 Aug. 2001; on wood of fallen, rotten branch of deciduous tree, 1 June 1999 (all specimens) S. Ripková (SLO); same locale, on fallen trunk of *Populus* sp., 13 May 1993, S. Adamčík (BRA); Bratislava – municipal part Podunajské Biskupice, deciduous forest (*Acer, Cornus, Fraxinus, Populus, Quercus, Robinia, Salix, Swida, Ulmus*) at the SW Slovnaft's refinery edge, Q 7869c, ca 135 m, on wood of fallen, rotten trunk of *Fraxinus* sp., 2 Aug. 2002, S. Ripková (SLO). Strážovské Vrchy Mts., Nitrianske Rudno, valley of the Rudnianka stream, 330 m, on dead branch of Salix caprea, 14 July 1984, J. Kuthan [as *C. mollis*] (BRA). Vihorlatské vrchy Mts., valley of the Dielový potok stream, ca 3 km SW from a church in Podhorod', ca 250 m, on bark of fallen, decaying trunk of Salix caprea, 12 June 2002, S. Ripková (SLO). Bukovské vrchy Mts., Kalná Roztoka (district of Humenné), ridge of Nastaz Mts., on the slope of Kalidlo hill, Nature Protected Area of Havešová, 650 m, on fallen trunk of *Fagus sylvatica,* 21 June 1991, J. Terray [as *C. applanatus*] (BRA); Kalná Roztoka, on fallen branch of *Fagus sylvatica,* 18. Sept. 1995, S. Adamčík [as C. mollis] (BRA). **Bulgaria:** Nature Protected Area of "Ropotamo", Reserve of "Veliov vir", valley of the Ropotamo river, 30 m, on decaying trunk of *Fraxinus* or *Ulmus*, 15 June 1972, J. Kuthan (BRA). **Ukraine:** Eastern Carpathians, mixed virgin forest (*Abies alba, Fagus sylvatica*), on the ridge of Menchul [Menčul] Mts., between the Kuzy and Bredecel rivers, near the town of Dilove [Trebušany], 800-1200 m, on *Fagus sylvatica,* Aug. 1934, A. Pilát (PRM 23483); same locale (PRM 23481); Eastern Carpathians, forest at the Kuzy river, near the town of Vel. Bichkiv [Veľký Bočkov], 350-1000 m, on Padus avium, July 1933, A. Pilát (PRM 23482); same locale, on *Fagus sylvatica* (PRM 23484); Eastern Carpathians, mixed virgin forest (*Abies alba, Picea excelsa, Fagus sylvatica* etc.), valley of the Liščenka river, near the town of Dilove [Trebušany], 800-1000 m, on *Fagus sylvatica,* Aug. 1936, A. Pilát (PRM 28616) [all specimens as *C. applanatus* f. *kuzyanus*]

Discussion

Aime (2004) showed that some members of *Crepidotus* in subsection *Fulvifibrillosi* produced hyphae of variable pigmentation in culture, ranging from hyaline to deep orange. This variation in pigmentation mirrors that which we have found in fruitbody development from a single thallus in the field. It was also demonstrated *via* mating studies that collections identified as *C. nephrodes* and *C. crocophyllus* were intercompatible in North America, although she did not treat the taxonomy of this group. Our analysis of the sequencing data suggests that *C. crocophyllus* in Central Europe is also most likely part of this same biological species although we were unable to obtain single spore isolates of the Slovak collections in order to test mating compatability. Nevertheless, all available data suggest that *C. crocophyllus* is a common fungus in hardwood forests throughout North America and Europe that is variably pigmented throughout its range.

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Cistella grumosa, a new species from leaves

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Abstract - A new species of *Cistella*, found on fallen leaves of maple, oak and sweet chestnut is described from Switzerland, Germany, France and Estonia. The species is characterized by its asci having hemiamyloid (Lugol red) apical rings and consistently lacking croziers. The other characters like subfusoid, small ascospores, hairs with a distinctly clavate warted upper cell and cylindrical paraphyses not exceeding the asci, are typical of the genus.

Key words - Ascomycetes, *Hyaloscyphaceae,* taxonomy, central Europe

Introduction

Cistella Quel. (nom. cons., = *Clavidisculum* Kirschst.) is one of the largest genera of *Hyaloscyphaceae* subfam. *Hyaloscyphoideae*. 42 species are included in this genus in A. Raitviir's forthcoming revision of this subfamily. They occur on a wide range of substrata, forest debris, dead herbaceous stems, wood and bark. Their apothecia are small and inconspicuous and for this reason they are easily overlooked.

On fallen maple, oak, and sweet chestnut leaves in moist environments a minute ascomycete has been observed since several years, for which no suitable taxon name could be found. The species has been published as *Cistella* spec. in Beyer (1998: 177). Therefore we decide to describe this fungus as a new taxon.

Material and Methods

The descriptions and illustrations are based on both fresh and dried material. Observations on living cells are marked by (*), those on dead cells by (†). Measurements are separated according to their state. Those of the dead spores are obtained in lactic acid Cotton blue CB (20 spores per collection), indicated are the calculated 95% confidence intervals and in brackets the observed minimum and maximum. A number in curled parentheses {} indicates the number of collections examined. The apical apparatus of the asci was checked in Lugol (IKI) and in Melzer's reagent (MLZ), without and with pretreament by KOH according to Baral (1987). Herbaria are abbreviated according to Holmgren et al. (1990).

Taxonomic Description

Cistella grumosa Baral, Senn-Irlet & Aeberhardt sp. nov. FIGURES 1-2

Apothecia discoidea vel cupulata, sessilia, usque ad 0.7 mm lata, minuter pilosa, alba ad eburnea ut cremea. Excipulum externum textura prismatica, cellulis tenuiter tunicatis, hyalinis, ad basem crassotunicatis et cum exsudato ochraceo. Pili ad marginem clavati, plerumque 1-septati, in apice spinulosi vel tuberculati, Asci cylindraceo-clavati, octospori, *37-75 x 5-6.5 μm, in apice conici, cum annulo apicale hemiamyloideo, basi non uncinati. Ascosporae subfusiformes vel clavatae, *5-7(-9) x 1.7-2.8 μm, non septatae, hyalinae, guttulis paucis minutis, in ascis biseriatae. Paraphysae cylindraceae, apice subflexuosae.

Ad folia caduca *Aceri*, *Castaneae* et *Quercus*.

Holotypus: Helvetia, Posieux, *Acer platanoides*, 29.11.2003, H. Aeberhardt & B. Senn-Irlet 93/189 (ZT, isotypus G).

Etymology: *grumosus* (adj.), referring to the small granules on the hairs.

KEY CHARACTERS – small apothecia with white to isabelline disc, spores small, subfusoid, containing a few minute oil drops, clavate hairs inflated part with small warts, asci with hemiamyloid apical rings, arising from simple septa, on fallen leaves.

EXPANDED DESCRIPTION - **Apothecia** superficial, scattered to gregarious, sessile to substipitate, cup- to saucer-shaped, eventually flat. Disc (0.15-)0.3-0.5(-0.7) mm diam., white to cream, isabelline, mat. **Receptacle** at first almost globose, then cup- to disc-shaped, white when fresh, minutely downy. **Ectal excipulum** near margin composed of textura prismatica oriented at low angle to the surface, at lower flanks and inner parts towards textura angularis-globulosa, cells 8-12 x 3-5 μm in upper part, thin-walled, walls hyaline, in lower part 10-16 x 4-7 μm, here in KOH distinctly thick-walled (gelatinized), in basal stipe part and also on lower flanks with yellowish-brownish intercellular exudate. **Hairs** at margin and middle flanks clavate, (0-)1(-2) septate, hyaline, terminal cell firm-walled, densely granulosewarty especially

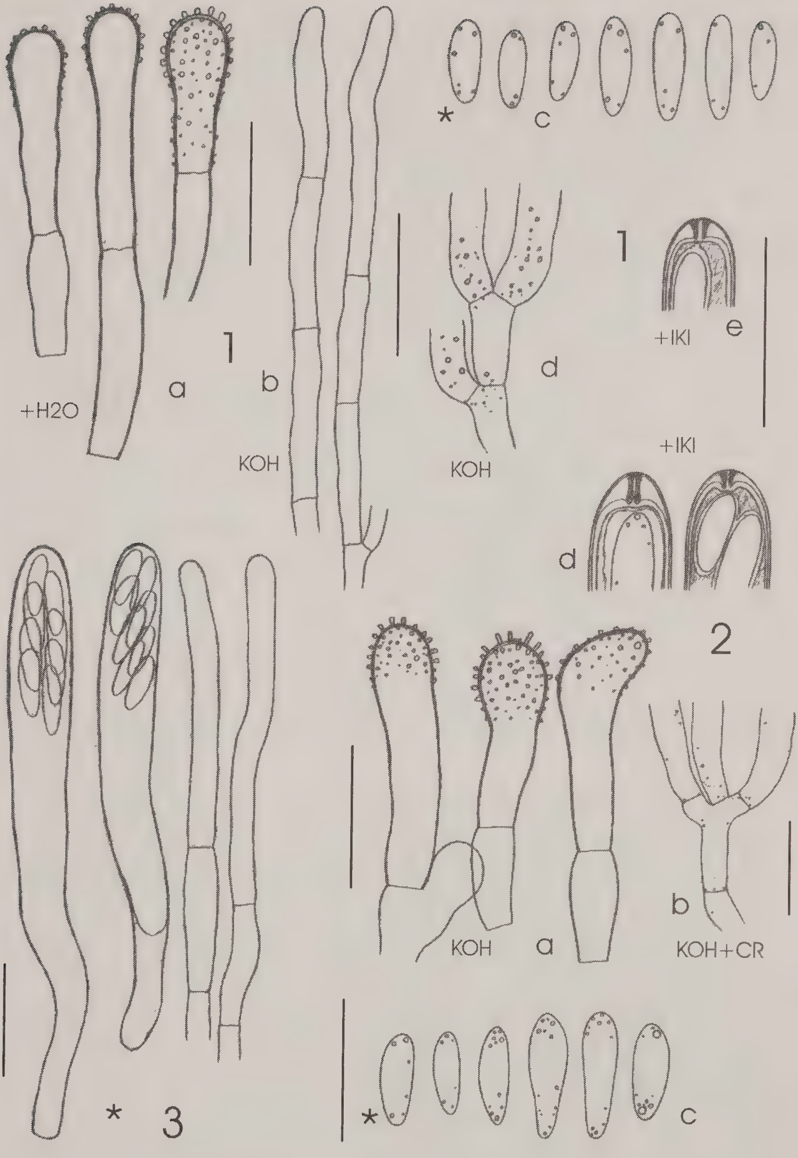
+H2O
a
1
b
KOH
*
c
d
KOH
1
e
+IKI
+IKI
d
2
KOH
a
b
KOH+CR
*
3
*
c

Figure 1: *Cistella grumosa* (1 Bavaria, 2 Dept. l`Hérault, 3 Stuttgart -Weilimdorf 1976). 1a) +2a) Hairs at apothecial margin, 1b) + 3) asci and paraphyses, 1c) + 2c) ascospores, 1d) + 2b) ascus bases arising from simple septa, 1e) + 2d) ascus apices in IKI (stained red, unpretreated); bars = 10 μm. Drawn by HB

in inflated apical part, warts roundish, at apex sometimes or often elongate rod-shaped (spiny), hardly stained in CB, (*) without visible inclusions, *23-35(-40) x 4-6 μm {3}, †(19-)23-35 x 3.7-4.8(-5.8) μm {2}, terminal cell 10-19 μm long. Hairs on lower flanks similar or sometimes narrowed towards apex (cylindrical to subulate), 15-25 x 2-3 μm large, with low warts or even smooth, arising from much broader cells of the excipulum. **Asci** consistently arising from simple septa (aporhynchous) {6}, cylindric-clavate, *(37-)45-60(-75) x 5-6(-6.5) μm {4}, †29-55 x 3.5-4.8 μm {2}, 8-spored, apex (sub-)conical, apical pore MLZ - or very faintly greyish, IKI+ medium to strongly hemiamyloid {6} (more or less dirty red-brown in concentrated Lugol, faintly blue in diluted Lugol, type RB or nearly RR), deep blue in MLZ or Lugol after KOH-treatment. **Ascospores** obliquely biseriate within both living and dead asci, cylindric to (sub-)fusoid or obliquely ellipsoid to subclavate, with a few minute guttules (LBs) at each end, *(5-)5.5-7(-9) x (1.7-)2-2.5(-2.8) {8}, †(4.5-)5-6(-7) x 1.8-2 μm {1}, Q = (1.5-)3.1-3.2(-4), hyaline, aseptate, smooth. **Paraphyses** cylindrical, straight to often slightly flexuous towards apex, apex rounded to obtuse, not or slightly exceeding the dead asci, *(2-)3-3.5(-4) μm broad (†1.7-2.3 μm), terminal cell 12-19 μm long, usually longer than lower cells, hyaline, (*) without visible contents (or sometimes with a slightly refractive vacuole). - No reaction of hairs, cell walls of ectal and medullary excipulum in KOH, neither in IKI or MLZ (with or without KOH-pretreatment).

ECOLOGY, RANGE, AND DISTRIBUTION – In more or less shady humid microhabitats, on the lower and mostly also upper face of fallen previous year's, non-sceletonized leaves of maple (*Acer platanoides* {4}, *A. pseudoplatanus* {1}, *A. campestre* {1}), oak (*Quercus robur* {2}, *Quercus* sp. {1}), or sweet chestnut (*Castanea sativa*) {1}, inserted on the net veins, seemingly also on the intercostal area. Growing associated with *Calycellina lachnobrachya* {3}, ?*Cylindrotrichum* {1}, *Hyalopeziza ciliata* {1}, *Hyalopeziza pygmaea* {1}, *Incrucipulum ciliare* {1}, *Mollisina acerina* {1}.

SPECIMENS EXAMINED: SWITZERLAND: Ct Fribourg, Posieux, campus of the agricultural highschool, on fallen leaves of *Acer platanoides*, under a juniper shrub, 29. XI. 2003, leg. H.U. Aeberhard & B. Senn-Irlet (HOLOTYPE coll. B.S-I. 03/189 ZT, ISOTYPE G). Ct Solothurn, Biberist, small park near railway station, on fallen leaves of *Acer platanoides,* 1.XII.2003, leg. H.U. Aeberhard (coll. 123.2003, ZT). Ct Schaffhausen, Merishausen, Randen, Osterberg, MTB 8217/2, 650 m, on leaves of *Acer campestre*. 11.XI.1989, H.-O. Baral & P. Blank (H.B. 3921b). ESTONIA Tatumaa Co., Uderna close to Elva, on fallen leaves of *Acer platanoides*, 11.IX.1966, coll. A. Raitviir (TAA-44314). GERMANY: Baden-Württemberg, Stuttgart- Weilimdorf, Alte Burg Dischingen, MTB 7220/2, 380 m, on leaves of *Quercus robur*, 26.IX.1976, H.-O. Baral. – Stuttgart-Weilimdorf, Vogelsang, MTB 7220/2, 400 m, on leaves of *Quercus*, 7.XI.1975, H.-O. Baral. Stuttgart - Weilimdorf, Frauenholz, 7120/4, 350 m, on leaves of *Acer pseudoplatanus*, 3.X.1975, H.-O. Baral. – Tübingen-Pfrondorf, Mähder, MTB 7420/4, 395 m, on leaves of *Quercus robur*, 25.X.1986, H.-O. Baral (H.B. 3103). Singen, Gottmadingen, NSG (south of forest Allmen), MTB 8218/4, 435 m, on leaves of *Quercus*, 18.XI.1987, P. Blank & H.-O. Baral. Bayern, Tannenbach, Waldhüttener Wald, MTB 6035, 250 m, on leaves of *Acer platanoides*, 18.X.1997, W. Beyer (H.B. 5959a). FRANCE: Dept. de l`Hérault, La Tour-sur-Orb, Camp- Nègre, 500 m, on leaves of *Castanea sativa*, 14.XI.2003, G. Garcia (H.B. 7437, G.G. 03111408).

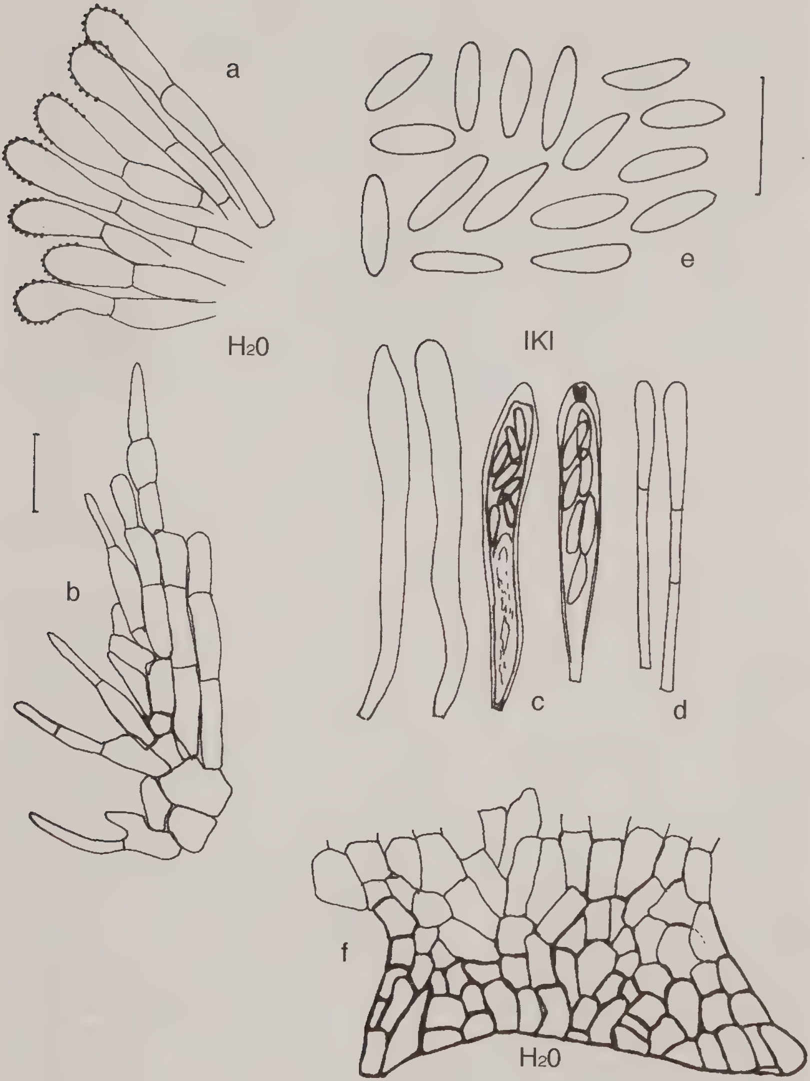

Figure 2: *Cistella grumosa* (B.S-I. 03/189). * Hairs at apothecial margin, b) * hairs on flanks, c) † asci, d) † paraphyses, e) † ascospores, d) * excipulum at base of stipe; bars = 10 μm. Drawn by B.S-I.

COMMENTS - The character combination of this small species of *Hyaloscyphaceae* with granulose hairs in the upper outer part of the apothecium fits perfectly with the circumscription of the genus *Cistella* Quél. 1886 emend. Nannfeldt (1932) and Raschle (1978). However, spore size, disc colour, and especially hemiamyloid apical rings and absence of croziers, together with substrate preference form a unique character combination at species level. The asci vary strongly in length, while spore size is rather conform among the collections studied. For instance, the collection from southern France (H.B. 7437) had asci 46-55 x 4.2-4.8 µm while that from Bavaria (H.B. 5959) only 29-45 x 3.5- 4.4 µm (both in KOH).

Using the dichotomous key of Vesterholt in Hansen & Knudsen (2000), the present species comes close to *Cistella grevillei* (Berk.) Raitv. 1978, a species on herbaceous stems which, in the wide sense of Raschle (1978), is described with a remarkably large variability in spore length (5.5-12 µm). The coloured picture given by Vesterholt (1994) shows a collection of densely gregarious, deeply cup-shaped fruit-bodies with yellowish discs, features not observed in our collections. Specimens corresponding well to this illustration and descriptions have been found by us very often, yet always fruiting on herbaceous stems. Baral (in Baral & Krieglsteiner, 1985) points to the fact that at least two species have been mixed up with *Cistella grevillei*. However, our species neither fits any of the discussed species, *C. grevillei* s.str. nor „*Dasyscyphus*“ *aconiti* Rehm (=*Cistella aconiti* (Rehm) Raitv. & Järv, non s. Raitviir & Järv, 1997).

The length of the hairs and the number of septa vary to some extend among the collections of *C. grumosa* studied. The hairs of *C. grevillei* are sometimes much longer, but often also very similar as in *C. grumosa*, in both length, shape, and granulation. The paraphyses of *C. grevillei* are consistently straight and tend to be a bit lanceolate. Yet, three fundamental differences between the two species were found, based on personal collections of *C. grevillei* (Baral, ined.): (1) the asci in *C. grevillei* consistently arise from croziers, and (2) have a euamyloid apical ring (reacting blue at any iodine concentration in both IKI and MLZ, without pretreatment). Furthermore (3), in a number of specimens of *C. grevillei* the entire medullary excipulum reacts distinctly blue in IKI (without pretreatment), a character which has apparently never been reported in the literature. This reaction could in no case be obtained in our specimens of *C. grumosa*.

It is, however, not consistently present in the collections of *C. grevillei* s.str. studied, and further variation among them concerning hair and ascospore characters suggests that *C. grevillei* is a collective species, even in its restricted sense in Baral & Krieglsteiner (1985). There is a further species of *Cistella* growing on fallen leaves, *C. deflexa* (Graddon) Raitv. 1979. This species appears to be not rare in Europe. It has a similar spore size (*5-7.5(-9.8) x 2-3(-3.4) µm according to recent collections), but differs in having longer, apically tapering or even lageniform hairs which are either straight or often curved at the apices, and again in the asci arising from croziers and having euamyloid apical rings (after recent personal collections, Baral, ined.). *C. attenuipilus* Graddon 1986 with straight attenuated hairs appears to be a later synonym (A. Raitviir, pers. comm.).

Another leaf-inhabiting species is *Cistella mussooriensis* Raitv. & M.P. Sharma 1987. It is rather close to our species in ascus and spore size, but differs in shorter hairs, being up to 25 µm long, which are occasionally encrusted with golden-brown caps of resinous matter. Asci arise from croziers, the apical rings are very pale blue in IKI (type BB), but unstained in MLZ even after KOH pretreatment (A. Raitviir, pers. comm.).

Fuscolachnum misellum (Desm.) Haines 1989 (= *Dasyscyphus acerinus* (Cooke & Ellis) Dennis), on leaves of *Acer* and *Rubus*, has similar sized asci and spores, and likewise hemiamyloid apical rings, but differs in the presence of croziers, the hairs being entirely covered by brownish warts, and the ectal excipulum being strongly gelatinized (Baral, ined.).

Hyaloscypha parenchymatosa Velen., described in Velenovskˇ (1934: 277, pl. 14, fig. 13) on leaves of *Quercus*, has been compared with our new species by Baral (in Beyer, 1998). In contrast to *C. grumosa* the hairs are described as smooth and the apothecia as very small (0.1-0.2 mm). Furthermore the ascus stalks are drawn by Veleonvskˇ with strong basal swellings which suggest that they arise from croziers. Hence *H. parenchymatosa* cannot be conspecific with our taxon. According to Svrcek (1985), the lectotype is empty and other authentic material does not match the protologue. Huhtinen (1990: 240) believes that Velenovskˇ´s description allows to conclude that *H. parenchymatosa* is a synonym of *Calycellina myriadea* (Mout.) Huhtinen.

Acknowledgments

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A new species of *Anthostomella* on *Magnolia liliifera* from northern Thailand

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Abstract—*Anthostomella monthadoia* sp. nov. collected from dead leaves of *Magnolia liliifera* in northern Thailand is described and illustrated with interference light micrographs. The new species is compared with similar taxa and a key to species of *Anthostomella* from Thailand is provided.

Key words—litter fungi, saprobe

Introduction

Anthostomella Sacc. (*Xylariaceae, Xylariales*) has been recently monographed by Lu and Hyde (2000) who accepted 86 species. In *Anthostomella* ascomata are usually immersed beneath a clypeus, asci are broad-cylindrical, with a J+ (or J-) subapical ring, and ascospores are brown and unicellular, often with a germ slit (Francis 1975, Lu et al. 1998, Lu & Hyde 2000). The genus includes species with a variety of ascospore shapes, and ascospores which may incorporate dwarf cells, appendages or mucilaginous sheaths (Francis 1975, Lu & Hyde 2000). The genus is widely distributed in tropical and temperate regions (Hyde, 1996; Lu et al. 1998; Lu & Hyde 2000). None of the 2600 specimens examined in the monograph of Lu and Hyde (2000) were from Thailand. In this paper we describe a new species of *Anthostomella*, list all reports of *Anthostomella* species from Thailand and provide a key to *Anthostomella* species from Thailand.

Materials and Methods

Fallen, dead, brown leaves of *Magnolia liliifera* Baill. (Magnoliaceae). were collected from Doi Suthep-Pui National Park, Chiang Mai, Thailand during the rainy season between June and September 2001. Leaves were returned to the laboratory in individual plastic bags and incubated with the addition of tissue paper moistened with sterilized water. Samples were examined periodically for the presence of microfungi, for up to two weeks. Fungi were mounted in water for examination with differential interference contrast microscopy. A single spore isolation technique (Choi et al. 1999) was used for isolating the living culture, but this case ascospore did not germinate. Small pieces of the leaves containing the fungi were cut and dried and prepared as herbarium specimens. These are deposited in Herbarium PDD.

Taxonomy

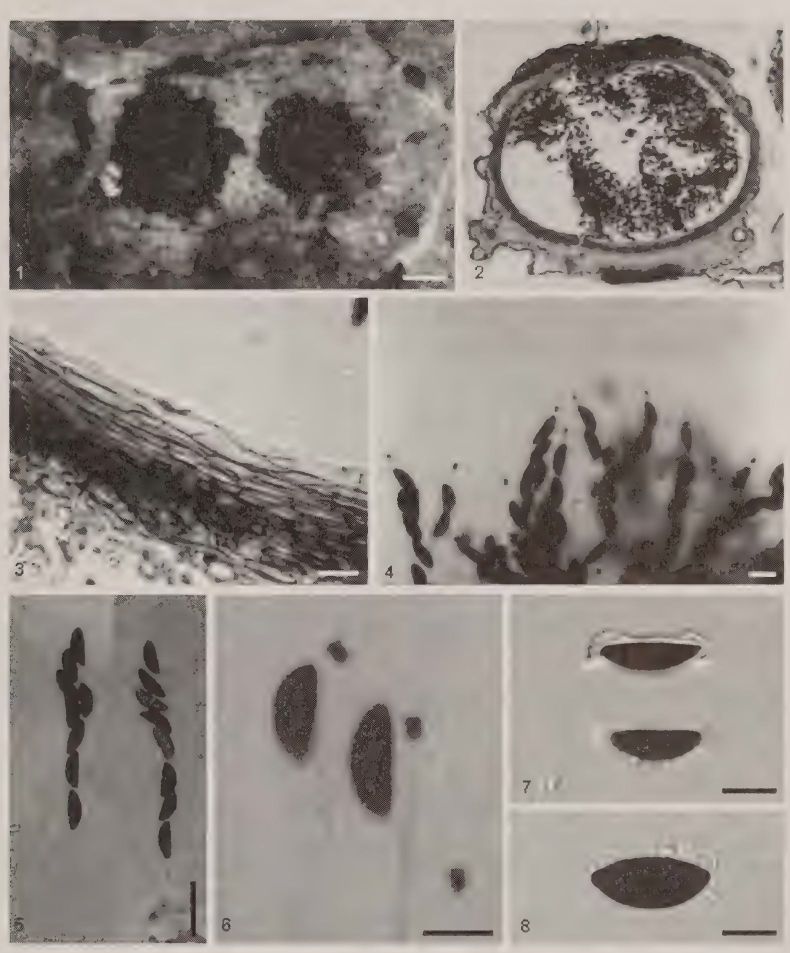
Anthostomella monthadoia I. Promputtha, **sp. nov.** Figs. 1-8

> *Ascomata* 650 μm diametro, 560 μm alta, subglobosa, immersa, clypeata, ostiolata, solitaria vel gregaria. *Asci* 117-135 × 8-10 μm, cylindrici, apparatu subapicali iodo coerulescente, 2-2.5 μm diam., 3-3.5 μm alta. *Ascosporae* 14-17.5 × 5-6.5 μm, ellipsoideae, brunea, unicellulae, tunica gelatinosa praeditae, germen directus.
>
> Etymology: in reference to common name of the host, *Magnolia liliifera* (monthadoi).
>
> Holotype: Thailand, Doi Suthep-Pui National Park, Chiang Mai, on dead leaves of *Manglietia garrettii*, 4 August 2001, I. Promputtha, PDD 77119.

Ascomata forming under blackened areas on the leaf surface, visible as slightly raised black circular areas, with a central ostiole, solitary or clustered in groups of 2-3 (Fig. 1). In vertical section, 650 μm diam., 560 μm high, subglobose, immersed beneath a clypeus (Fig. 2). *Clypeus* black, occupying the upper epidermal layer only, filled with black hyphae. *Peridium* 18-24 μm wide, comprised of several layers of pale brown compressed cells (Fig. 3). *Paraphyses* up to 2 μm diam., up to 170 μm long, hypha-like, irregular, tapering, septate, numerous and not embedded in a gelatinous matrix (Figs. 4). *Asci* 117-135 × 8-10 μm ($\bar{x}$= 125.5 × 9.7 μm, n = 20), 8-spored, cylindrical, unitunicate, long pedicellate, apically rounded, with a J+, wedge-shaped, subapical ring, 2-2.5 μm diam., 3-3.5 μm high (Figs 5-6). *Ascospores* 14-17.5 × 5-6.5 μm ($\bar{x}$= 16.1 × 5.9 μm, n = 20), overlapping uniseriate, ellipsoidal, dark brown, unicellular, smooth walled, surrounded by a mucilaginous sheath with hyaline cap-like appendages at both ends, with a straight ventral germ slit, extending over the full-length (Figs 7-8).

Discussion

Anthostomella is a species-rich genus containing more than 86 species (Lu et al. 2000). *Anthostomella monthadoia* is most similar to *A. francisiae* K.D. Hyde, *A. longa* B.S. Lu & K.D. Hyde, *A. lucens* Sacc. and *A. scirpi* B.S. Lu & K.D. Hyde (Table 2). *Anthostomella monthadoia* is similar to *A. scirpi* in ascospore shape and size, but the ascus lacks a visible apical apparatus in *A. scirpi* (Table 2). *Anthostomella monthadoia* is similar to *A. longa* in the shape of its ascal ring, but the ascal ring is longer in the former and ascospores are also longer (Table 2). *Anthostomella monthadoia* ascospores are similar to *A. francisiae* in shape and being surrounded by a mucilaginous sheath and also in having a straight full-length germ slit. The ascospores of *A. francisiae* are however, much larger as is the ascal ring (Table 2). *Anthostomella lucens* differs in asci having a larger apical ring and the direction of germ slit (Table 2). These differences in characters indicate that *A. monthadoia* is new.



Figures 1-8. *Anthostomella monthadoia* (from holotype). 1. Fruiting bodies on the host surface. 2. Vertical section of an ascoma. 3. Peridium comprising several layers of pale brown compressed cells. 4. Squash mount of ascoma contents, showed paraphyses. 5. Asci containing ascospores. 6. Ascus apex with a J+, wedge-shaped, subapical ring. 7. Ascospores surrounded by a mucilaginous sheath with hyaline cap-like appendages at both ends. 8. Ascospore with a straight ventral germ slit, extending over the full-length. Bars: 1 = 100 μm, 2 = 200 μm, 3 = 50 μm, 4-5 = 20 μm, 6-7 = 10 μm, 8 = 5 μm.

There are presently four species of *Anthostomella* known from Thailand (Table 1) (Sivichai et al. 2000, 2002; Promputtha et al. 2002; Photita et al. 2003) and a key is provided on the next page.

Key to *Anthostomella* species known from Thailand

1. Ascospores 10-12.5 × 5-6.5 μm, with a dwarf cell . . . . *A. clypeoides*
1. Ascospores lacking a dwarf cell 2

2. Ascospores 15-20 × 5-8 μm, with central germ slit which is shorter than the spore, on submerged wood in aquatic habitat . . . . *A. aquatica*
2. Ascospores with full length germ slit, terrestrial species 3

3. Ascospores 7.5-12.5 × 5-6.5 × 2.5-4 μm . . . . *A. tenacis*
3. Ascospores 14-17.5 × 5-6.5 μm . . . .*A. monthadoia*

Table 1. *Anthostomella* species from Thailand.

Taxa	Host	References
A. aquatica K.D. Hyde & Goh	Submerged *Dipterocarpus alatus*	Sivichai et al., 2000, 2002
A. clypeoides Rehm	Terrestrial *Musa* sp.	Photita et al., 2003
A. monthadoia I. Promputtha	Leaves of *Magnolia liliifera*	Promputtha et al., 2002
A. tenacis (Cooke) Sacc.	Leaves of *Magnolia liliifera*	Promputtha et al., 2002

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Table 2. Comparison of *Anthostomella monthadoia* with *A. francisiae*, *A. longa*, *A. lucens*, and *A. scirpi* (Hyde 1996, Lu and Hyde 2000).

	A. monthadoia (this paper)	***A. francisiae*** K.D. Hyde	***A. longa*** B.S. Lu & K.D. Hyde	***A. lucens*** Sacc.	***A. scirpi*** B.S. Lu & K.D. Hyde
Ascomata diam. × high (μm)	650 × 560	500-650 × 380-520	420-550 × 400-460	180 × 60	250 × 210
Ascus ring, diam. × high (μm)	Wedge-shaped, J+, 2-2.5 × 3-3.5	Cylindrical, J+, 3.5-4 × 5-6	Wedge-shaped, J+, 2-2.5 × 2-2.5	Stopper-shaped, J+, 4-5 ×3-4	Lacking an apical apparatus
Ascospores (μm)	14-17.5 × 5-6.5, ellipsoidal, dark brown	18-26 × 7-9, ellipsoid-fusiform, brown	16.5-20 × 5.5-6.5, oblong-ellipsoidal, brown to pale brown	15-18 × 7-9, inequilaterally ellipsoidal, brown	14-16 × 5-6.5, ellipsoidal, brown
Appendages /sheath	Hyaline cap-like structures at both ends	Surrounded by a thin mucilaginous sheath, with pad-like appendages	With two hyaline cap-like appendages	Surrounded by a mucilagenous sheath	Surrounded by a mucilaginous sheath
Germ slit	Straight, full length	Straight, full length	Straight, full length	Somewhat curved, full length	Straight, full length, Indistinct

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MYCOTAXON

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A new subspecies of *Menegazzia neotropica* (*Parmeliaceae*, *Ascomycota*) from Central America

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Abstract – Based on specimens collected by the second and third authors, the new subspecies *Menegazzia neotropica* ssp. *rotundicarpa* is described with a type specimen from Costa Rica. It differs from ssp. *neotropica* by the rounded, only slightly striate apothecia, the colour of the apothecial margins and the number of perforations. The new subspecies is also known from Venezuela and Mexico. It grows as an epiphyte in the subparamo zone.

Key words – lichens, Neotropics, infraspecific taxon, new records, Tapanti

Introduction

The lichen genus *Menegazzia* A. Massal. is characterised by inflated, perforated lobes. Around 50 species are known from the southern temperate forests of South America and Australasia. In tropical regions, the number of species is much lower, and they are restricted to upper montane forests between 2000 and 4000 m altitude (López Figueiras 1986, James et al. 2001, Bjerke 2002, Aptroot et al. 2003). Only three species are known from the Neotropics (Bjerke 2002). To the best of our knowledge, no species of *Menegazzia* have been reported from Costa Rica previously. In the checklist from Costa Rica, *Menegazzia* sp. is listed, but no species names are included (Umaña Tenorio et al. 2002). In this paper, the results from a study of Costa Rican and Mexican specimens of *Menegazzia* are presented.

Materials and methods

Specimens collected by the second author in Costa Rica, and the third author in Mexico were the basis for this study. Additional specimens from other areas of the world were also studied and compared with the Neotropical specimens. Acetone extracts were analysed according to standardised thin-layer chromatographic (TLC) methods (Culberson 1972, Orange et al. 2001) and by high performance liquid chromatography (HPLC) according to Feige et al. (1993) and Bjerke et al. (2002).

Taxonomic description

Menegazzia neotropica ssp. *rotundicarpa* Bjerke & Sipman *subsp. nov.*

FIGURE 1

> *Differt a subsp.* neotropica *apotheciis rotundis pedicellis leviter striatis.*
>
> ***Etymology:*** from the Latin *rotundus* = "almost circular", and *-carpus* = "-fruit" or "-fruited", thus referring to the shape of the apothecia.
>
> ***Typus*: COSTA RICA. PROV. SAN JOSÉ.** CERRO DE LA MUERTE, ALONG PANAMERICAN HIGHWAY, CA. 2 M TALL SCRUB WITH ROCK OUTCROPS, E OF CERRO BUENAVISTA, ALT. 3400 M, 83°46' W 9°33' N. 23 March 1985, *H Sipman 20953* (B 60 0052338 — holotype, BM 000761549 — isotype).

Key characters – *Menegazzia neotropica* is a species with a greyish upper surface, rather narrow, concave, glossy lobes occasionally with brownish tips, small, ellipsoid perforations, two-spored asci, and large spores (Bjerke 2002). Ssp. *neotropica* has apothecia with wavy, inflexed margins that hide most of the disc, and striate-fluted exciples and pedicels. The new subspecies shares morphological, anatomical and chemical characters with ssp. *neotropica*, except for the number of perforations and the shape and colour of the apothecia (Fig. 1), which are described as follows: **apothecia** common, rounded, short-pedicellate, 0.3-1.4 mm diam.; **discs** brown, slightly shining, visible, slightly concave, flat in mature apothecia; **margins** thin, smooth or faintly striate; **exciples** concolorous with thallus; **pedicel** smooth or slightly fluted. **Ascomatal layers, asci** and **ascospores** as in ssp. *neotropica.*

Chemistry – Atranorin, chloroatranorin, stictic acid aggregate (as in ssp. *neotropica*). Two unidentified substances were detected by TLC in one specimen, but they were not detected by HPLC, and it may be that they were contamination from soredia or other thallus fragments of associated species.

Distribution and ecology – *Menegazzia neotropica* ssp. *rotundicarpa* grows in humid subparamo vegetation at elevations between 2500 and 3500 m in the Costa Rican mountain ranges and in similar habitats in Mexico and Venezuela. The second author has observed it mostly on old shrubs in scrub vegetation on old fire sites or bogs, but is likely to occur as well in the canopy of taller forest. It seems to avoid recent fire sites, and associates with many of the same taxa as ssp. *neotropica* in the Andes, viz. species of *Parmotrema*, *Heterodermia*, *Oropogon*, *Usnea* and *Hypotrachyna*. One specimen is overgrown by *Normandina pulchella.*

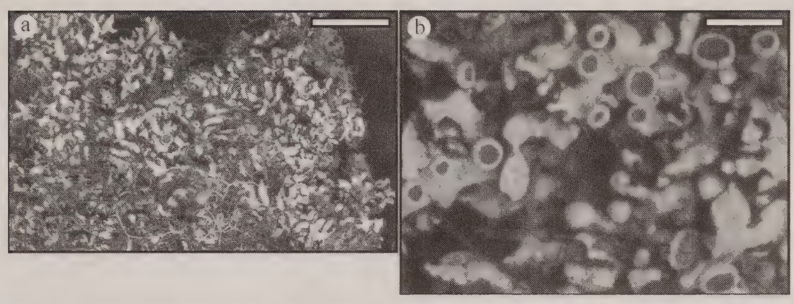

Fig. 1. *Menegazzia neotropica* ssp. *rotundicarpa* (holotype). a) part of thallus, b) cluster of apothecia. Scale: a = 10.0 mm, b = 3.0 mm.

Discussion – The differences in ascomatal characters are considered as a taxonomically relevant character, since the specimens from Costa Rica and Mexico have the same kind of apothecia, which are not found in specimens from the Andes, except in one Venezuelan specimen (Bjerke 2002). This specimen, cited by Bjerke (2002), has apothecia that are of the '*rotundicarpa*'-form, and is therefore included in the new subspecies. An additional distinguishing character is the colour of the margins of the apothecia, which in ssp. *neotropica* is often dark brownish. The new subspecies also tends to have fewer perforations. The holotype for instance, has only a single perforation. Some minor, morphological overlap exists between the two entities, as some apothecia of ssp. *rotundicarpa* have slightly striate margins. Moreover, not all specimens of ssp. *neotropica* have distinctly brownish margins, and the number of perforations is variable within both subspecies. Because of some morphological overlap in the distinguishing characters, and since the two taxa are similar in all other respects, separation at the species level is not considered appropriate. As the distinction between the varietal and the subspecific ranks within lichen systematics is not well founded, and the selection between these ranks seems to be determined more by tradition than scientific argument, we here follow the northern European tradition of using subspecific rank (see e.g. Kärnefelt 1979, Timdal 1991). With its rounded apothecia, *M. neotropica* ssp. *rotundicarpa* is more similar to some other fertile species of *Menegazzia*, as opposed to ssp. *neotropica* with its particular apothecium morphology. *Menegazzia megalospora* (Räsänen) R. Sant., a Chilean endemic, is the most similar species, but it differs in having a dull, brownish upper surface, sinuously radiating and convex lobes, and pruinose lobe tips (Santesson 1942, Bjerke 2005). *Menegazzia neotropica* ssp. *rotundicarpa* also differs from some species recently described from Taiwan (Aptroot et al. 2003) in having larger spores and less convex and narrower lobes.

ADDITIONAL SPECIMENS EXAMINED (PARATYPES). COSTA RICA. Cartago. Parque Nacional Tapanti (AC Amistad Pacífico), Tres de Junio, km 70 on road (ruta 2) from Cartago to San Isidro, roadside. Alt. 2750 m. 83°51' W; 9°39' N. 2002, *H Sipman 48286* (B 60 0111630). **MEXICO.** Oaxaca. Ixtlán de Juárez, 2001, *RE Pérez S6-46* (MEXU). **VENEZUELA. Estado Mérida.** Páramo de San José de Acequias, near Zanjón del Cupís, s. annum, *M López-Figueiras 30184* (B 60 0048724).

Acknowledgements

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Synopsis of the lichen genus *Menegazzia* (*Parmeliaceae,* Ascomycota) in South America

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Abstract – The genus *Menegazzia* in South America is revised. Of the 20 species recognized, seven are fertile, esorediate "primary species" and 13 are rarely fertile, sorediate "secondary species." This paper revises the fertile species and provides notes on the sorediate species. The new combination *M. wilsonii* is proposed, and *M. albida* is relegated to synonymy. *M. hollermayeri* is shown to be conspecific with and synonymous to *M. dispora. M. valdiviensis* belongs to subgenus *Octospora*, not to subgenus *Dispora*, as previously suggested. The sorediate species *M. sanguinascens* is shown to be a norstictic, not hypothamnolic, acid-containing species. *M. norsorediata* is placed in synonymy with *M. sanguinascens*. The hypothamnolic acid-containing *Parmelia opuntioides* var. *violascens* is raised to species level as *M. violascens*. Argentinian reports of three Australasian sorediate species are rejected, and *M. kawesqarica* is reported as new to Argentina. Seventeen species, 14 endemic, are known from southern South America. Only three species are known from the tropical parts of South America. No species appear to occur in both areas. Notes on chemistry, distribution and ecology, and a key to the species are also included.

Key words – lichenized ascomycetes, taxonomy, Chile, chemotaxonomy

Introduction

Representatives of the lichen genus *Menegazzia* A. Massal. are common in the temperate and antiboreal forests of southern South America. In his revision of the genus, Santesson (1942) treated 11 species from southern South America, of which seven are primary species and four sorediate. Three species were new to science. Subsequently, knowledge of the sorediate species from southern South America increased considerably through descriptions of new species and new records of species previously known from Australasia (Calvelo & Adler 1994, Adler & Calvelo 1996, Bjerke 2001, Bjerke & Elvebakk 2001, Bernasconi et al. 2002, Bjerke et al. 2003a). There have not been any additions or changes to the list of primary species from southern South America after Santesson's (1942) treatment. The genus appears to be represented by much fewer species in tropical South America. Only three species, one with two subspecies, are known to occur there (Bjerke 2002, Bjerke et al. 2005), and none of these species is found further south.

Although previous treatments contributed significantly to our knowledge of South American species, there are still some unsolved problems. The objective of this study was to evaluate taxonomic, nomenclatural, chemical and biogeographical aspects that still were not treated sufficiently in previous studies. The study of type specimens of critical taxa was needed to solve some problems. The major focus was given to the primary species, since the sorediate species were recently revised in detail (Bjerke 2001, 2002, Bjerke & Elvebakk 2001, Bjerke et al. 2003a). However, some additional notes on the sorediate species are included in the present account, with emphasis on studies of type specimens and the contrasting views presented by Bernasconi et al. (2002) on one hand and Bjerke & Elvebakk (2001) and Bjerke et al. (2003a) on the other. One new combination is made, one taxon is raised to species level, three lectotypifications are made, some names are reduced to synonymy with other taxa, and three species reports from Argentina are rejected.

Materials and methods

The species of *Menegazzia* were studied in the field in Chile. My own collections and herbarium collections from South America and other continents, including numerous type specimens, housed in B, BAFC, BG, BM, CHR, GB, GZU, H, HO, HIP, LE, MEL, MERF, MSC, S, TROM, TUR, UPS, UV and W were carefully studied in the laboratory. ICBN citations refer to the Saint Louis code (Greuter et al. 2000). Thin-layer chromatography (TLC) of acetone extracts was performed using standardized procedures (Culberson 1972, Orange et al. 2001). Selected specimens were also analysed by reversed-phase high-performance liquid chromatography (RP-HPLC) using the equipment and methods described by Bjerke et al. (2002), but with a longer gradient run. The mobile phase consists of methanol and 1 % orthophosphoric acid in ultra-pure water. The proportion of methanol was increased from 30 % to 63 % during 4 min, then to 72 % during 21 min, and finally to 86 % during 5 min at 1.2 ml min^{-1}, giving a total run of 30 min. Specimens with known content of acetone-soluble secondary metabolites were used as references, in addition to commercial samples of atranorin (A-6652, Sigma-Aldrich Chemie GmbH, Steinheim, Germany; consisting of both atranorin and chloroatranorin) and usnic acid (U-7876, Sigma-Aldrich Chemie GmbH). HPLC chromatograms and UV spectra are shown for selected species. As the UV spectra are taken from the photodiode array detector, the conditions under which the spectra are measured depend on the retention time of the substances. Thus, the spectra shown here deviate slightly from those obtained in, for example, pure ethanol.

Brief descriptions are given for the primary species in southern South America. Full descriptions of all species are given in Santesson (1942), Calvelo & Adler (1994), Adler & Calvelo (1996), Bjerke (2001, 2002, 2003), Bjerke & Elvebakk (2001), Bernasconi et al. (2002) and Bjerke et al. (2003a, 2005). Unless otherwise stated, notes on morphology, chemistry, distribution and habitat ecology of the sorediate species follow Bjerke (2001, 2002, 2003), Bjerke & Elvebakk (2001), and Bjerke et al. (2003a).

The primary species

1. *Menegazzia cincinnata* (Ach.) Bitter

Hedwigia 40: 172 (1901) ≡ *Parmelia cincinnata* Ach., Meth. Lich.: 252 (1803); type: Ad Fretum Magellanicum, *A Menzies s.n.*. (E — lectotype designated by Galloway 1995: 103), ≡ *Lichen cincinnatus* Sm. ex Ach., Meth. Lich.: 252 (1803) nom. illeg. ≡ *Lichen bullatus* Menzies ex. Ach., Lich Univ.: 495 (1810) nom illeg. ≡ *Parmelia cincinnata* Lam., Encycl. Method. Bot., Suppl. Vol. 3: 406 (1813) nom. illeg.

Note: The lectotype is annotated by Menzies "…Staten Land near Cape Horn – Feb: 1787 A:M" (Galloway 1995). The term 'Ad Fretum Magellanicum' was incorrectly designated by J. E. Smith in his correspondence with E. Acharius (Galloway 1988). Additional Menzies material is in BM (!), E, Linn-SM (Galloway 1995), and in S. A photograph of the S material is available online [http://linnaeus.nrm.se/botany/ kbo/ach/ps/l1196.html.se].

Thallus ±closely attached, forming small to large, irregular rosettes, 2-10 cm wide. **Lobes** 1.2-2.0 mm wide, convex, contiguous and overlapping at margins, irregularly branched. **Upper surface** smooth, dull, slightly maculate, slightly corrugate towards centre, pale yellow or yellowish-grey, often with a greenish tinge, often with black patches towards centre, pale brown at apices. **Perforations** sparse to numerous, 0.2-0.7(-1.0) mm wide, rounded or more rarely irregularly shaped; rim plane or slightly elevated, often blackened. **Soralia** and **isidia** absent. **Lower surface** black towards centre, brown and glossy towards apices, eperforate. **Medullary cavity** cottony, white above, occasionally with scattered, pale yellow spots, ±yellow-brown in apices, black below. **Apothecia** numerous, laminal, rounded at first, becoming more irregular, to 7 mm wide, short-pedicellate; medullary layer under hymenium faintly to conspicuously yellow in the upper part. **Disc** concave at first, becoming plane or slightly convex, epruinose, red-brown. **Thalline exciple** concolorous with thallus or pale-brown, irregularly crenulate to more or less entire, 0.1-0.5 mm wide. **Ascospores** 8 per ascus, 19-28 × 12-18 μm; wall 1.3-2.5 μm. **Pycnidia** numerous; ostiole brownish.

Chemistry – Usnic acid (major to minor; generally not more than 1.0 % of thallus dry weight), lecanoric acid (major; in apothecia only as trace), thamnolic acid [absent to trace, but major in one specimen (*J. W. Bjerke* 226/98)], two unidentified compounds; the first one, "Unid. 1" (absent to minor) with retention time at 6.9 min and with UV spectrum similar to that of lecanoric acid (Fig. 1), the second one, "Unid. 2" (trace to minor, always present) with retention time at 12.7 min, and also with a UV spectrum similar to that of lecanoric acid, which has a retention time of 13.5 min (Fig. 1). On TLC plates, Unid. 2 is yellowish orange after charring, pale brownish with halo in solvent B, partly overlapping lecanoric acid in solvents A and C, and is slightly above lecanoric acid in solvent B. It is not gyrophoric acid. The medulla in apothecia is faintly or conspicuously yellow-orange. The colour is caused by several pigments, which on HPLC chromatograms appear as small peaks with low retention times. Their UV spectra are reminiscent of anthraquinones, see *M. valdiviensis* below. Santesson (1942) regarded the presence of a yellow medulla in apothecia as a constant character, but in some specimens the content is so low that the medulla is more or less white.

Comments – Santesson (1942) also reported that the upper surface of the medullary cavity in the lobe apices is yellow. A pure-yellow colour was not seen in any specimens, but some specimens do have a pale-brown colour with a tinge of yellow in the medulla. This is the same colour as is found on the outer surface of the lobe apices. These melanin-like pigments are not acetone-soluble. In addition, some specimens have scattered pale, yellow spots in the upper part of the medulla. These spots appear to be caused by usnic acid, which has been transported from the upper cortex to the medulla. The occurrence of usnic acid in the medulla has also been detected in other lichens (Millanes & Vicente 2003).

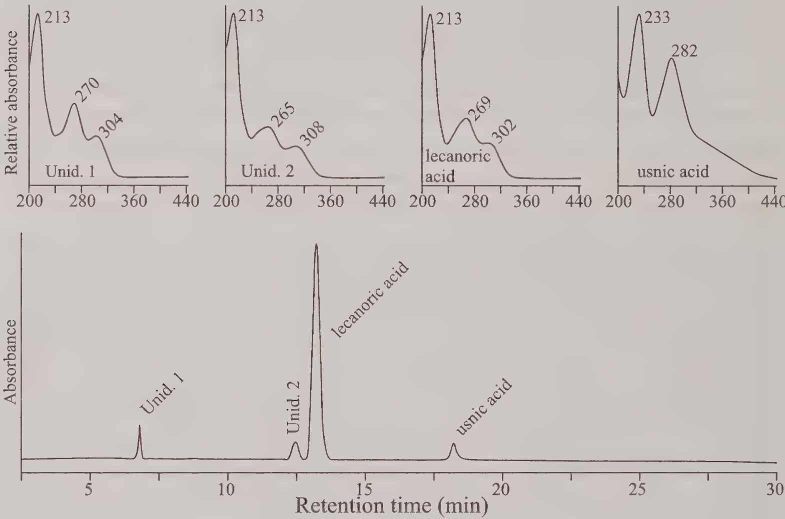


Fig. 1. Representative HPLC chromatogram of acetone extract of *Menegazzia cincinnata* (*A. Elvebakk 96:132*). Four substances were detected: “Unid. 1” (6.8 min), “Unid. 2” (12.5 min), lecanoric acid (13.3 min), and usnic acid (18.2 min). The UV absorption spectra of the four substances are shown above. Wavelengths (nm) of absorption maxima are provided.

In his comparison of *M. cincinnata* and *M. valdiviensis*, Santesson (1942) focused on the differences in the shape of the thalline exciples, stating that the former species has thick, crenulate exciples, whereas the latter has thin, entire exciples. However, the thickness and crenulation of the thalline exciple of *M. cincinnata* is more variable than previously expected. It is correct that *M. cincinnata* generally has thicker exciples than *M. valdiviensis*. It normally has inrolled, crenulate exciples (Fig. 2a), but large, older apothecia of *M. cincinnata* tend to have quite thin exciples that are not much crenulate (Fig. 2b). The exciples in large, plane apothecia of *M. valdiviensis* are thin, occasionally almost concolorous with the disc (Fig. 2c), and in some parts not visible from the upper surface (Fig. 2d), whereas younger apothecia have slightly thicker, continuous exciples. Moreover, *M. valdiviensis* differs from *M. cincinnata* in containing trace amounts only of usnic acid and therefore having a less prominent yellow hue; by having mostly abortive or under-developed asci with no or a few spores only; by paler discs; by a glossier, not much blackened upper surface; by pale brownish to dark brown, and

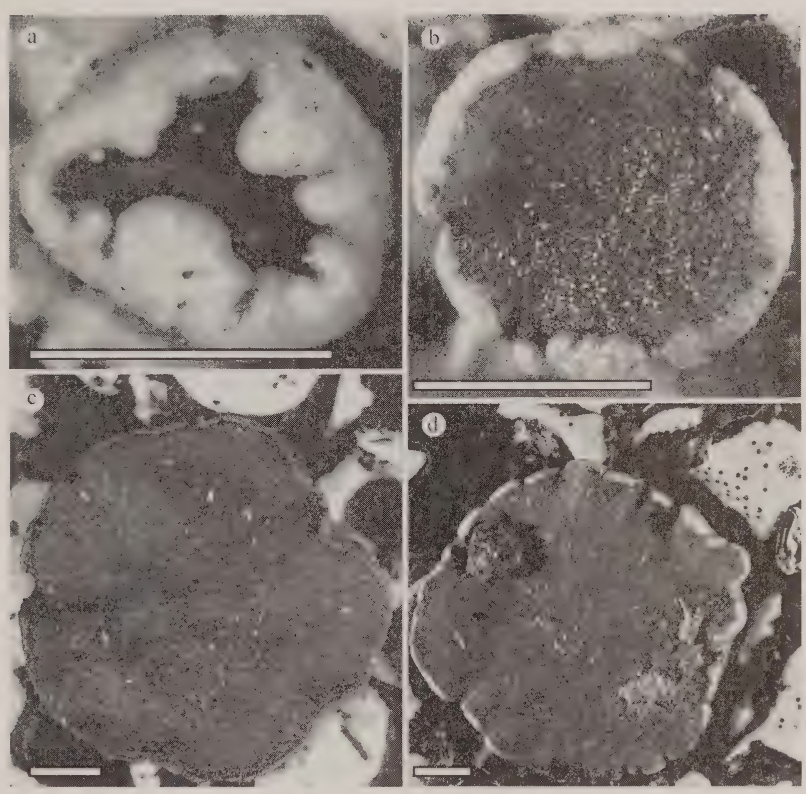


Fig. 2. Apothecial structures of two southern South American species of *Menegazzia*. a. *M. cincinnata* (*A Elvebakk 99:742*), young apothecium with, inrolled, crenulate exciple. b. *M. cincinnata* (*A Elvebakk 96:180*), mature apothecium with flat, not much crenulate exciple. c. *M. valdiviensis* (*A Elvebakk 95:379*), mature apothecium, with thin, entire exciple, which is concolorous with disc. d. *M. valdiviensis* (holotype), mature apothecium with thin, partly dissected exciple. Scale bars = 1 mm.

not black, lobe apices and margins; and by slightly wider, smooth, more convex and less contiguous and overlapping lobes. Some problematic specimens from northern Patagonia and central southern Chile are intermediates between typical *M. cincinnata* and typical *M. valdiviensis*. These specimens are here interpreted as a deviating type of *M. valdiviensis* (see under that species).

Menegazzia cincinnata has similar lobe morphology and chemistry to *M. globulifera*, although the content of minor substances occasionally differs. The two species may constitute a species pair.

Distribution and habitat ecology – Distributed in southernmost South America from approximately 46°00' S (Laguna San Rafael) to the southernmost part of Tierra del

Fuego, which is in accordance with Santesson (1942). No specimens from the northerly regions were here identified with certainty as *M. cincinnata*. Thus, its occurrence north of Laguna San Rafael was not confirmed (cf. reports from Nahuel Huapí by Calvelo & Adler 1994). It is an epiphyte in *Nothofagus* forests (*N. pumilio*, *N. betuloides*, *N. antarctica*), but is also known from other phorophytes such as *Drimys winteri* and *Embothrium coccineum*. It prefers smooth-textured bark of trees growing in open conditions, but generally not as dry as its sorediate counterpart, *M. globulifera*.

ADDITIONAL SELECTED SPECIMENS EXAMINED – ARGENTINA. Prov. de Tierra del Fuego. 2km E of Cerro Chenen, 1989, *J Poelt s.n.* (GZU). **CHILE. XII Región de Magallanes: Prov. de Última Esperanza**. Parque Nacional Bernardo O'higgins, Estero Peel, Puerto Témpanos, 17.VI.1908, *C Skottsberg s.n.* (UPS). Parque Nacional Bernardo O'higgins, Glaciar Serrano, 1998, *JW Bjerke 257/98, 220/98* (UV), *226/98* (TROM). Parque Nacional Torres del Paine, 3km nw of Refugio Pingo, 1998, *A Elvebakk 98:230 & JW Bjerke* (TROM). **Prov. de Magallanes**. ISLA DESOLACIÓN, 16.IV.1896, *P. Dusén s.n.* (S-mixed with and labelled *M. opuntioides*). PENÍNSULA BRUNSWICK, LAGUNA EL PARRILLAR, 1975, *J Redon 76* (HIP). **Prov. de la Antárctica Chilena.** HERMITE ISLAND, CAPE HORN, *J Hooker 64* (BM-two packets), IDEM, 1883, *Hariot s.n.* (UPS); BORJA BAY, 1895, *Vanadis-exped. s.n.* (UPS).

2. *Menegazzia dispora* (Nyl. ex Cromb.) R. Sant.

Ark. Bot. 30A, 11: 13 (1942); type: Patagonia, Fortune Bay, 16.XII.1868, *RO Cunningham s.n.* [H — holotype, BM ! — isotype (on two different sheets)] ≡ *Parmelia dispora* Nyl. ex Cromb., Bot. J. Linn. Soc. 15: 228 (1876) ≡ *Imbricaria dispora* (Nyl. ex Cromb.) Jatta, Nuov. Giorn. Bot. Ital. Nov. ser. 12: 50 (1890) = *Parmelia hollermayeri* Räsänen, Revista Univ. (Santiago) 22: 196 (1937); type: Chile, Valdivia, Cordillera Pelada, Calminalhue, 1936, *RPA Hollermayer 1145* [H ! — lectotype; designated by Santesson, 1942: 23; duplicate of lectotype in S ! ("isolectotype")] ≡ *Menegazzia hollermayeri* (Räsänen) R. Sant., Ark. Bot. 30A, 11: 22 (1942).

Note: The type locality "Fortune Bay" is probably the bay at the southeastern part of Isla Grande now known as Bahía Buen Suceso.

Thallus ±loosely attached, radiating, forming small to large patches, 4-15 cm wide. **Lobes** 1.5-3.5 mm wide, convex, dichotomously to anisotomically branched, wide-angled, often with open spaces between lobes. **Upper surface** smooth, glossy at apices, dull towards centre, slightly maculate, slightly corrugate towards centre, greenish grey, often becoming brown towards centre; lobe apices not or faintly brown. **Perforations** sparse, 0.3-1.5 mm wide, rounded or ovoid, often gaping; rim plane or slightly elevated, occasionally blackened. **Soralia** and **isidia** absent. **Lower surface** black and scrobiculate towards centre, brown, patchily white and glossy towards apices, rarely with small perforations at apices. **Medullary cavity** cottony, white above, pale yellow towards apices, black below. **Apothecia** numerous, laminal, short-pedicellate, cupuliform at first, becoming flat, to 10 mm wide; medullary layer under hymenium white. **Disc** concave at first, becoming plane or irregularly undulate, epruinose, red-brown to brown. **Thalline exciple** concolorous with thallus, irregularly crenulate and thick in young apothecia, more or less entire and thin in old apothecia, 0.1-0.4 mm wide. **Ascospores** 2 per ascus, yellowish brownish when immature, becoming hyaline, 38-56 × 25-36 μm when mature, smaller when immature; wall 1.8-4.5 μm. **Pycnidia** abundant; ostiole dark brown to black.

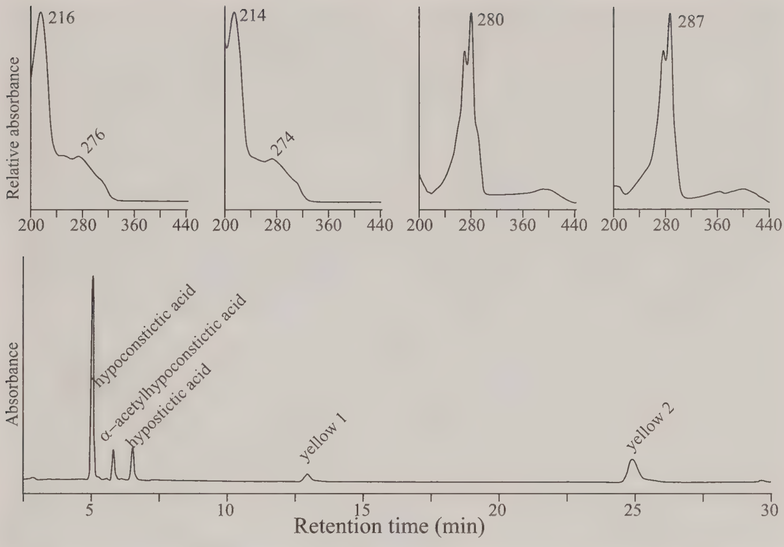


Fig. 3. Representative HPLC chromatogram of acetone extract of *Menegazzia dispora* (*J. W. Bjerke 506/01*). Five substances were detected: hypoconstictic acid (5.4 min), α-acetylhypoconstictic acid (6.2 min), hypostictic acid (6.8 min), and two unidentified yellow pigments, called "Yellow 1" (13.1 min) and "Yellow 2" (24.7 min), see text for further explanation. The UV absorption spectra of four of the substances are shown above. The UV spectrum of hypostictic acid is almost identical to that of α-acetylhypoconstictic acid and is therefore not shown. Wavelengths (nm) of absorption maxima are provided.

Chemistry – Atranorin (absent to minor), chloroatranorin (absent to minor), hypostictic acid (minor), hypoconstictic acid (major), α-acetylhypoconstictic acid (minor), see also Elix et al. (1985); two yellow pigments (trace to minor, UV+ white, K+ yellow-orange). The yellow pigments were not identified, but their UV spectra are highly characteristic with low absorption in the low UV-C and in the UV-A bands, but with absorption maxima in the UV-B band (Fig. 3). HPLC analyses on thallus fragments with the yellow hyphae removed did not contain detectable amounts of the two compounds with characteristic UV spectra. Thus, it was concluded that these are the yellow pigments. The two yellow pigments appear to be present in all specimens, but in some specimens with very low amounts. Atranorin and chloroatranorin is not present in all specimens (Fig. 3), but they were detected in the isotype of *M. dispora*.

Comments – Räsänen (1937) gave a brief description of *Parmelia hollermayeri* but did not state how it differed from related species. According to Santesson (1942), the key difference between *M. hollermayeri* and *M. dispora* is the shape of the thalline exciples of the apothecia, the former species having thin, more or less entire exciples, and the latter having thick, crenulate exciples. In his comparison of the two taxa, Santesson (1942) considered the placement of the perforations, the structure of the lower side, the size of the apothecia and the thickness of the spore walls to be additional relevant, distinguishing features (Table 1). Of these characters, Räsänen (1937) mentioned only the apothecia, which he stated to be 2-8 mm wide in *M. hollermayeri*.

After comparing type material and other specimens of the two taxa, it is concluded here that the differences mentioned by Santesson (1942) are not sustained. The thickness of the ascomatal margins varies with size and age of the apothecia, old apothecia having thin margins and younger ones having thicker, more crenulate margins (Fig. 4a-c). The isotype of *M. dispora* has one apothecium that is 10 mm wide (Fig. 4a) and another one that is 7 mm wide, both having a more or less entire thalline exciple. Thus, *M. dispora* certainly also has apothecia that are larger than 4 mm in diam. No differences in spore size and thickness in spore walls were detected here. Spore walls are between 1.8 μm and 4.5 μm thick, and both the isotype of *M. dispora* and the lectotype of *M. hollermayeri* have spores with walls thicker than 4.0 μm. The report of spores with walls up to 9 μm thick was not confirmed here. It is correct that the perforations in the lectotype of *M. hollermayeri* are confined to the lobe tips. However, the syntype and numerous other studied specimens from Valdivian rainforest have perforations along the median line of the lobes, and some even have minute perforations on the lower side of lobe tips. Consequently, none of the distinguishing features given by Santesson (1942) are supported here. The types also have identical chemical content, viz. the highly characteristic hypostictic acid chemosyndrome (= the quintaria group; see Moroney et al. 1981), which is very rare in *Menegazzia*. Based on these reasons, *M. hollermayeri* is here relegated to synonymy with *M. dispora*.

Santesson (1942) reported spores sizes of *M. dispora* up to 89 × 47 μm. No spores larger than 56 × 36 μm were found in the present study, whereas Bernasconi et al. (2002) reported maximum spore size to be 60 × 40 μm.

Table 1. Morphological, anatomical and distributional differences between *M. dispora* and *M. hollermayeri* according to Santesson (1942).

Character / species	***Menegazzia dispora***	***Menegazzia hollermayeri***
Placement of perforations	Median line of lobes	Confined to the margins and the tips of the lobes
Structure of lower surface of lobes	Scrobiculate, sometimes with a few small perforations	Rugulose, opaque, without perforations
Size of apothecia	To 4 mm diam., usually smaller	To 8 mm diam., the large ones perforated in the centre
Size of spore walls	Very thick, up to 9 μm	To 3 μm
Distribution range	Southwest Patagonia, Tierra del Fuego	Valdivian forests

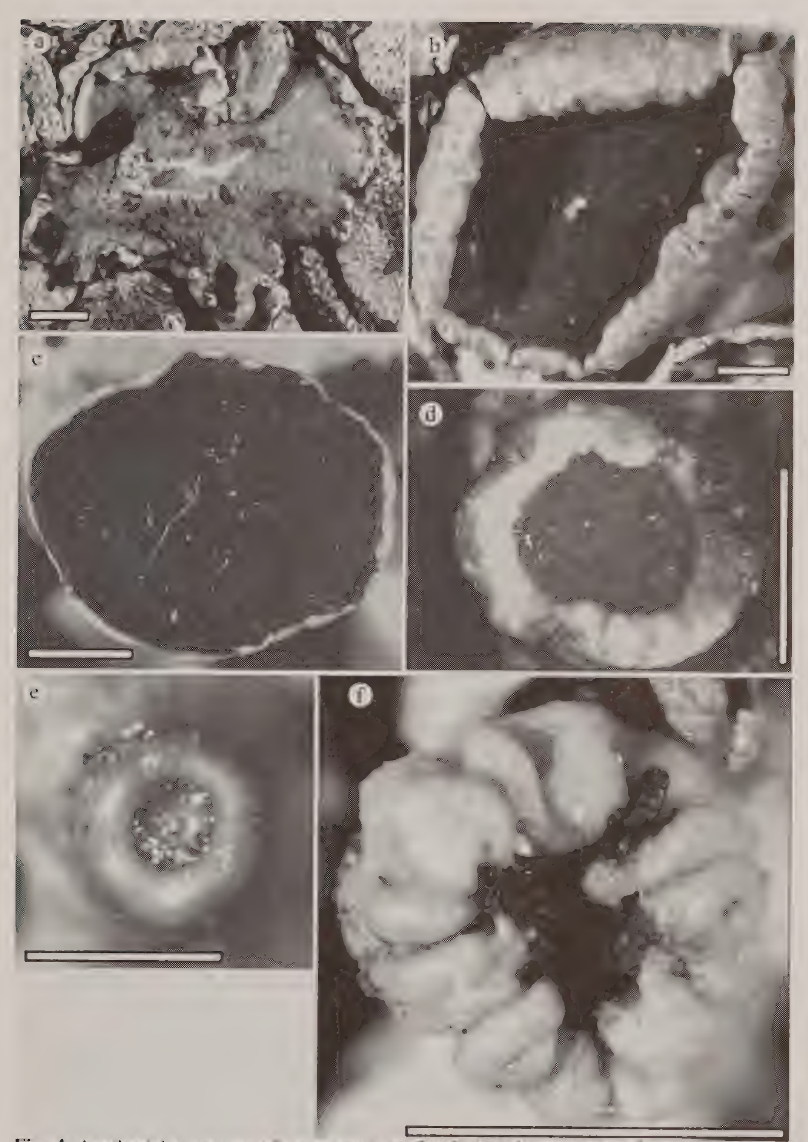


Fig. 4. Apothecial structures of some southern South American species of *Menegazzia*. a. *M. dispora* (isotype), hymenium lacking (consumed by insects?). b. *M. dispora* (lectotype of *M. hollermayeri*), exciple curling inwards. c. *M. dispora* (syntype of *M. hollermayeri*), flat disc with very thin exciple. d. *M. megalospora* (isotype), with partly blackened exciple. e. *M. wilsonii* (lectotype). f. *M. opuntioides* (*P Dusén 28*). Scale bars = 1 mm (a-d, f), 0.5 mm (e).

Distribution and habitat ecology – In southern South America along the Cordilleras from latitude 38°30' S (Parque Nacional Conguillío) to the south-western parts of the Magellanic Region at latitude 53°40' S. *M. dispora* is an epiphyte in wet, lush forests. It grows on twigs of understory vegetation, e.g. on *Desfontainia spinosa*, *Fuchsia magellanica*, *Maytenus magellanica*, *Pseudopanax laetevirens*, *Ugni molinae*, and on species of *Gaultheria*, *Pernettya* and *Schinus* in well-developed *Nothofagus* forests. It also inhabits twigs and branches, and not so much the trunks, of trees such as *Aextoxicon punctatum*, *Araucaria araucana*, *Drimys winteri*, *Embothrium coccineum*, *Eucryphia cordifolia*, *Fitzroya cupressoides*, *Laureliopsis philipiana*, *Nothofagus betuloides*, *N. dombeyi*, *N. nitida*, *Persea lingue*, and *Pilgerodendron uviferum*. It avoids the shadiest parts of the understory and is most common towards edges or openings in the forest. It is one of the most common species of *Menegazzia* in Valdivian and North-Patagonian rainforests. In southern Patagonia and Tierra del Fuego, it is confined to the Magellanic moorland and the southern temperate-antiboreal rainforests. Elix et al. (1985) did not state the origin of the material analysed by them, but give the impression that the species is present in Australasia. However, it was not included in the treatments of *Menegazzia* in New Zealand (James 1985) and Australia (James & Galloway 1992).

ADDITIONAL SELECTED SPECIMENS EXAMINED – **ARGENTINA. Prov. de Tierra del Fuego.** York Bay [Isla de los Estados], "Fretum Magellanicum", IX.1853, *sine collectoribus 1339* (BM). **CHILE.** Sine loco, *EC Reed* (?) *22* (BM). **IX Región de la Araucana. Prov. de Cautín.** Parque Nacional Conguillío, 5-10 km N of Visitor's centre, 1995, *A Elvebakk 95:381* (TROM). Parque Nacional Villarica, NW slope of volcano, 1972, *PW Rundel 7447* (BM). **X Región de Los Lagos. Prov. de Osorno.** Parque Nacional Puyehue, Anticura, Los Derrumbes, 1986, *BJ Coppins et al. 4589* (BM). Parque Nacional Puyehue, 5 km from Antillanca, *BJ Coppins et al. 5341* (BM). **Prov. de Valdivia.** C. 3 km E of Lago Riñihue and 3 km N of Enco, 2001, *JW Bjerke 1505/01* (TROM). 8.4-11.4 km SW of Choshuenco, 1986, *BJ Coppins et al. 4088, 4115, 4153, 4391, 4459, 4472* (BM). Enco, 1940, *R Santesson 3738* (BM). Cordillera Pelada, La Nueva, 27.I.1934, *RPA Hollermayer s.n.* (H-syntype of *Parmelia hollermayeri*). 60 km W of La Union on road to Hueicolla, 1985, *PF Cannon 173* (BM). El Mirador, 24.I.1969, *M Mahu s.n.* (BM). **Prov. de Llanquihue.** Parque Nacional Vicente Pérez Rosales, southern slope of Volcán Osorno, 2001, *JW Bjerke 703/01* (TROM). Parque Nacional Vicente Pérez Rosales, Petrohué, 2000, *JW Bjerke 506/01* (TROM). Río Petrohué, near falls, 1986, *BJ Coppins et al.* 4688, 4775, 5198, 5209 (BM). 1 km W of Lago Chapo, 2001, *JW Bjerke 837/01* (TROM). **Prov. de Chiloé.** Parque Nacional Chiloé, slopes above Lago Huelde, *BJ Coppins et al. 5018* (BM). **XII Región de Magallanes. Prov. de Última Esperanza.** Eden Harbour [Puerto Edén], 1868, *RO Cunningham s.n.* (UPS-labelled "cotypus"). Newton Island, Columbine Cove, 1896, *P Dusén 47* (S). **Prov. de Magallanes**. Port grappler, 1869, *RO Cunningham s.n.* (BM 000761541). Isla Desolación, Puerto Angusto, 1896, *P Dusén 187, 227a* (S). Península Brunswick, Bahía Fortesque, 1969, *H Imshaug 44910 & K Ohlsson* (BM).

3. *Menegazzia megalospora* (Räsänen) R. Sant.

Ark. Bot. 30A, 11: 21 (1942); type: Tierra del Fuego, Fiordo Martínez [Chile], 20.II.1929, *H Roivainen s.n.* (H ! — holotype, S ! — isotype) ≡ *Parmelia megalospora* Räsänen, Ann. Bot. Soc. Zool.-Bot. Fenn. 'Vanamo' 2, 1: 18 (1932).

Note: Räsänen (1932) mentioned only one locality, Fiordo Martínez at Isla Grande, from where Roivainen collected this species. Thus, the specimen in H from that locality should be regarded as the holotype (cf. Art. 9.1, Note 1 and Rec. 9A.4), whereas the duplicate in S is an isotype. Räsänen (1932) also provided an illustration of the holotype.

Thallus firmly attached, forming small, compact, irregular rosettes, 2-5 cm wide. **Lobes** slightly concave to slightly convex, 0.5-1.5 mm wide, short, imbricate especially towards centre, subdichotomously branched. **Upper surface** smooth, glossy, slightly corrugate towards centre, grey or greyish green, black in patches, totally black towards centre, brown at apices, occasionally pruinose; pruina ice blue to white; margins black. **Perforations** sparse, sometimes lacking, small, 0.1-0.5 mm wide, rounded; rim plane or slightly inrolled. **Soralia** and **isidia** absent. **Lower surface** glossy, scrobiculate, black towards centre, brown only at the outermost tip, with a few perforations at apices. **Medullary cavity** white or black above, black below. **Apothecia** numerous, rounded, small, 0.8-1.5(-2.0) mm wide, sessile or short-pedicellate; medullary layer under hymenium white. **Disc** concave, epruinose or rarely faintly pruinose, red-brown to brown. **Thalline exciple** grey or patchily black, smooth to irregularly crenulate, often incurved, 0.2-0.3 mm wide; upper cortex of exciples occasionally eroding. **Ascospores** 2 per ascus, very large, 60-98 × 32-60 μm; wall 5-12 μm [to 17 μm according to Santesson (1942)]. **Pycnidia** numerous; ostiole brown to black, apices colourless.

Chemistry – Atranorin (absent to major), chloroatranorin (absent to major), stictic acid (major), constictic acid (major), cryptostictic (minor), menegazziaic acid (minor), additional satellite compounds (trace), and norstictic acid (absent to trace). Surprisingly, only chloroatranorin, and no atranorin, was detected by HPLC analyses of a fragment of the isotype. Quilhot et al. (1975) reported that *M. megalospora* contains lecanoric acid and salazinic acid. The voucher specimens from their study are lost (W. Quilhot pers. comm., see also Bjerke et al. 2003a), but the specimens they based their analyses upon are probably referable to *M. valdiviensis*, as they found lecanoric acid.

Comments – *Menegazzia megalospora* is characterized by small, compact thalli; a grey to black upper surface almost without any perforations; small, apothecia (Fig. 4d) with blackened, smooth to crenulate exciples; and large spores with thick walls. It is similar to *M. neotropica* (see below).

Distribution and habitat ecology – In Chile along the coast from Chiloé (42°20' S) to the south-western part of Isla Grande (54°30' S). *M. megalospora* is an epiphyte in lush rainforest, which receives up to 7000 mm of precipitation annually. It grows on *Nothofagus betuloides* and associated species, often on tiny twigs less than 5 mm wide in understory vegetation (e.g. on *Berberis ilicifolia*). It is still a rarely collected species.

ADDITIONAL SPECIMENS EXAMINED – **CHILE. X Región de Los Lagos. Prov. de Chiloé**. Cordillera de San Pedro, 1958, *EJ Goodley 443* (BM). **XII Región de Magallanes. Prov. de Última Esperanza**. Canal Smith, Isla Piazzi, 31.V.1908, *C Skottsberg s.n.* (S, UPS). Fiordo Andrew, 1985, *A Newton L131 pp* (BM 000761548, BM 000761550-mixed with *M. neozelandica*). idem, 1985, *A Newton L147 pp* (BM-mixed with *M. wilsonii*). **Prov. de Magallanes**. Port Grappler, 9.XII.1874, *RO Cunningham s.n.* (BM). Isla Desolación, Puerto Angusto, 1896, *P Dusén 227b* (S, UPS), *228b* (S). Isla Desolación, Bahía Tuesday, 1969, *H Imshaug 44684 & K Ohlsson* (GZU).

4a. *Menegazzia neotropica* Bjerke ssp. *neotropica*

Lichenologist 34: 505 (2002); type: Colombia, Depto. Cauca, Municipio Puracé, Cordillera Central, along road La Plata-Puracé, 2 km W of Laguna San Rafael, alt. 3300 m., on *Diplostephium* in c. 3 m tall, open scrub in paramo bog, 6.X.1984, *J Aguirre C & HJM Sipman 5983* (B 44745 ! — holotype).

Comments – *Menegazzia neotropica* ssp. *neotropica* is characterized by short-pedicellate apothecia with prominent, sinuous, corrugate, ridged, inrolled exciples that partly obscure the discs; concave, glossy lobes with brown-black margins; and small perforations with inrolled rims. It contains atranorin and the stictic acid complex. It is described in detail and illustrated in Bjerke (2002). It shares several characters with *M. megalospora*, but differs by having epruinose lobes; numerous perforations; inrolled, ridged exciples; and a less blackened upper surface.

Distribution – This subspecies is known from high altitudes in the Neotropics (Ecuador and Colombia). The Venezuelan specimen listed by Bjerke (2002) was subsequently transferred to *M. neotropica* ssp. *rotundicarpa* (Bjerke et al. 2005.). *M. neotropica* ssp. *neotropica* is here reported from some additional provinces in Ecuador. See Bjerke (2002) for notes on ecology.

ADDITIONAL SELECTED SPECIMENS EXAMINED – **ECUADOR. Prov. de Carchi.** Road Tulcán-Santa Bárbara, the pass, 1983, *L & A Arvidsson 3376* (GB). **Prov. de Tungurahua.** Llanganati Mt., near Amed Cocla, 1967, *RIM Garrett & JF Farra 1018* (BM). **Prov. de Azuay.** Road Cuenca-Molleturo, 25 km W of Cuenca, *L & A Arvidsson 4136-4141* (GB). Road Cuenca-Loja, 15 km S of Cumbre, 1983, *L & A Arvidsson 4308, 4309* (GB). **Prov. de Loja.** Road Cuenca-Loja, ca. 6 km south of Saraguru, 1979, *L Arvidsson & D Nilson 1966* (BM).

4b. *Menegazzia neotropica* ssp. *rotundicarpa* Bjerke & Sipman

Mycotaxon 91: 419–422 (2005); type: Costa Rica: Prov. San José, Cerro de la Muerte, along Panamerican Highway, Ca. 2 m tall scrub with rock outcrops, E of Cerro Buenavista, alt. 3400 m, 83°46' W 9°33' N. 23.III.1985, *H Sipman* 20953 (B 60 0052338 ! — holotype, BM 000761549 ! — isotype).

Comments – *Menegazzia neotropica* ssp. *rotundicarpa* differs from ssp. *neotropica* by having rounded apothecia with more or less smooth, entire pedicels and thalline exciples (Bjerke et al. 2005).

Distribution – *Menegazzia neotropica* ssp. *rotundicarpa* is a rarely collected species, known only from one locality in South America (Venezuela), and three localities in Central America (Bjerke et al. 2005).

5. *Menegazzia opuntioides* (Müll. Arg.) R. Sant.

Ark. Bot. 30A, 11: 25 (1942); type: Fretum Magellanicum, V.1883, *Hariot* 6 (UPS ! — holotype) ≡ *Parmelia opuntioides* Müll. Arg., Miss. Sci. Cap Horn, V Bot. Lich.: 159 (1889).

Thallus loosely to firmly attached, radiating, forming irregular rosettes, 3-7 cm wide. **Lobes** multiply segmented with numerous lobe segments and very narrow articulations, bud-like at apices; segments inflated, rounded to broadly ellipsoid, 0.5-4.0 mm wide, 0.5-5.5 mm long. **Upper surface** smooth, glossy at young segments, dull at older segments, lead grey or greyish green, becoming yellowish brown to black, pale brown at apices, black at articulations and margins, epruinose. **Perforations** scattered, 0-2 per segment, laminal or marginal, rounded, somewhat conical when marginal, 0.1-0.5 mm wide; rim plane or slightly elevated, frequently black. **Soralia** and **isidia** absent. **Lower surface** scrobiculate, black, brown in a small zone at apices, eperforate. **Medullary cavity** white or black above, black below, also present in articulations. **Apothecia** sparse to numerous, mostly at centre, cupuliform, rounded, 1.2-2.5 mm wide, short-pedicellate (Fig. 4f); medullary layer under hymenium white. **Disc** concave or plane, epruinose, dark brown. **Thalline exciple** concolorous with thallus or blackened, irregularly crenulate, often slightly incurved, 0.2-0.3 mm wide. **Ascospores** 2 per ascus, yellowish or hyaline, very large, 62-95 × 34-55 μm; wall 4-10 μm wide. **Pycnidia** sparse; ostiole dark brown.

Chemistry – Barbatic acid (major), 4-*O*-demethylbarbatic acid (minor), four other unidentified substances (absent to trace). Atranorin and chloroatranorin were not detected in any of the specimens examined. Bernasconi et al. (2002) reported that atranorin is sporadic in *M. opuntioides*.

Distribution and habitat ecology – In southern South America from latitude 40°30' S (Parque Nacional Puyehue) to the south-western part of Isla Grande. It becomes rarer towards the south, and is there restricted to the humid islands and fiords along the coast. It is an epiphyte of trees and shrubs in Valdivian and Patagonian rainforest, and in Magellanic moorland. It is known from the following phorophytes: *Dasyphyllum diacanthoides*, *Drimys winteri*, *Fitzroya cupressoides*, *Nothofagus betuloides*, *N. dombeyi*, and *N. pumilio* (see also Calvelo & Adler 1994).

ADDITIONAL SELECTED SPECIMENS EXAMINED – **ARGENTINA. Prov. de Río Negro.** Parque Nacional Nahuel huapí, Brazo Puerto Blest, Los Clavos, 29.XII.2001, *M Caldiz s.n.* (TROM). **CHILE. X Región de Los Lagos. Prov. de Osorno.** Parque Nacional Puyehue, Antillanca, 1986, *BJ Coppins et al. 4535, 4577, 4850, 5325, 5335* (BM). **Prov. de Llanquihue.** Parque Nacional Vicente Pérez Rosales, Puerto Manzano, slope of Cordillera Derrumbe, Cordillera Bonete, 1986, *BJ Coppins et al. 5012* (BM). Parque Nacional Vicente Pérez Rosales, Petrohué, 1986, *BJ Coppins et al. 4736* (BM). **XII Región de Magallanes. Prov. de Última Esperanza.** Fiordo Andrew, 1985, *A Teram 1061a* (BM), idem, 1985, *A Newton L159a* (BM). **Prov. de Magallanes.** Isla Desolación, 1896, *P Dusén 188* (BM, UPS), *s.n.* (S). Península Brunswick, Puerto Cutter, 1967, *H Imshaug 39332 & RC Harris* (GZU). **Prov. de Tierra del Fuego.** Isla Grande, Puerto Bueno, 1896, *P Dusén 28* (S).

6. *Menegazzia valdiviensis* (Räsänen) R. Sant.

Ark. Bot. 30A, 11: 26 (1942); type: Chile, Valdivia, Cordillera Pelada, La Reina. Cortícola, 900 m. 30.XI.1934, *RPA Hollermayer 1146* (H ! — holotype, H ! — isotype) ≡ *Parmelia* (*Menegazzia*) *valdiviensis* Räsänen, Revista Univ. (Santiago) 22: 197 (1937).

Note: Räsänen (1937) listed one particular specimen; namely "Herb. Gunckel No. 6883". Two packets with almost identical labels that are in accordance with the protologue exist in H. However, none of them has the Gunckel herbarium number, and only one of them is annotated "Typus!". It does not appear to be any specimens of *Parmelia valdiviensis* in H numbered 6883. Thus, the "Typus!" specimen is regarded here as the holotype. The other packet is regarded as an isotype.

Thallus ±firmly attached, forming small to large, irregular rosettes, 5-10 cm wide. **Lobes** 1.5-3.0 mm wide, convex, crowded, irregularly branched. **Upper surface**

smooth, glossy in parts, slightly maculate, greenish-grey or pale yellow-green, pale brown at apices, blackened along margins. **Perforations** sparse to numerous, small, 0.05-0.7 mm wide, rounded or ±oval; rim plane. **Soralia** and **isidia** absent. **Lower surface** black towards centre, brown and glossy towards apices, eperforate. **Medullary cavity** white above, black below. **Apothecia** sparse to numerous, laminal, cupuliform at first, rounded, to 7 mm wide, short-pedicellate; medullary layer under hymenium distinctly yellow-orange in the upper part or more rarely white. **Disc** concave at first, becoming plane or convex, epruinose, red-brown, often disintegrating (consumed by insects?). **Thalline exciple** concolorous with thallus or becoming pale reddish brown as the disc, thin, entire, glossy, smooth, with a very few lateral cracks, 0.1-0.2 mm wide, vanishing in older apothecia. **Ascospores** often not developed, 0-6(-8) per ascus, irregular in shape when poorly developed and then with a very thin wall, 19.0-29.5 × 11.0-18.0 μm when mature and well-developed, KOH+ brown; wall 1.0-2.6 μm. **Pycnidia** numerous; ostiole brownish.

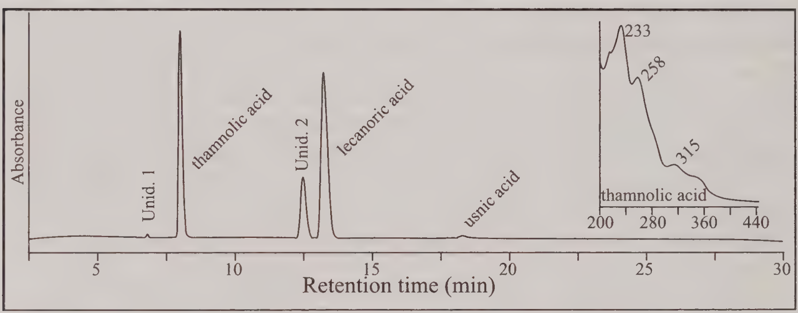


Fig. 5. HPLC chromatogram of acetone extract of *Menegazzia valdiviensis* (holotype). Five substances were detected: "Unid. 1", thamnolic acid (8.1 min), "Unid. 2", lecanoric acid, and usnic acid. Note the very small peak of usnic acid. The UV absorption spectrum of thamnolic acid is shown on the right. For retention times and UV spectra of the four other substances, see Fig. 1.

Chemistry – Lecanoric acid (major), thamnolic acid (absent to major; high content in holotype; Fig. 5), usnic acid (faint trace to trace, absent in apothecia), two unidentified compounds (the same as in *M. cincinnata*) called Unid. 1 (absent to trace) and Unid. 2 (minor to major). The content of usnic acid is generally too low to be detected by TLC, but a weak signal was detected by HPLC in all analysed specimens (Fig. 5). Unidentified K+ orange, UV+ white, yellow-orange medullary pigments accumulate in the medulla of the apothecia. The yellow pigments have low HPLC peaks (Fig. 6), are numerous and are difficult to separate by the gradient run used here. UV spectra for four of the pigments are shown in Fig. 6. The spot tests and UV spectra suggest that they are anthraquinones. They are generally in higher concentrations in *M. valdiviensis* than in *M. cincinnata*, and in the latter species only a few of them were detectable. There also seems to be some variation between specimens. For instance, two additional anthraquinone-like, yellow pigments were detected in a specimen from Nahuelbuta (*J. W. Bjerke 995/01*, not shown). The pigments appear to be different from the yellow anthraquinones reported to be present in the Australasian species *M. pertransita*

(Stirt.) R. Sant. and *M. jamesii* Louwhoff & Kantvilas (Kantvilas & Louwhoff 2004). Wavelengths (nm) of the absorption maxima are indicated. No peaks with retention time longer than 16 min were detected.

Not all specimens of *M. valdiviensis* have a yellow-orange medulla under the apothecia. The examined specimens of *M. valdiviensis* from Nahuel Huapí lack these pigments.

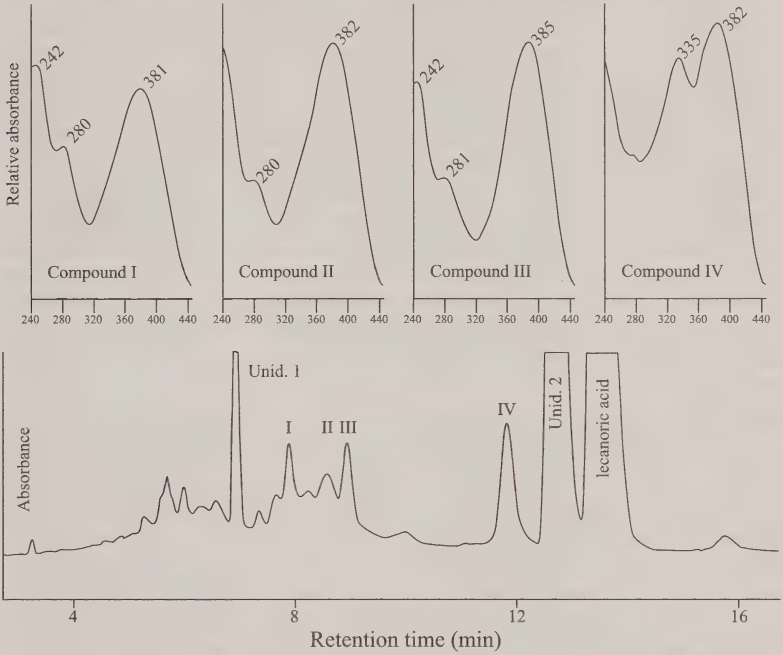


Fig. 6. Detail of HPLC chromatogram of acetone extract of yellow-pigmented medulla from the apothecia of *Menegazzia valdiviensis* (*A Elvebakk 00:582A*). Numerous confluent peaks were detected in the period between 5.2 and 11.8 minutes, each probably representing a pigment, except for the peak at 6.9 min (= "Unid. 1"). UV spectra are shown for four of these pigments, numbered I-IV. The spectra are cut at 240 nm due to noise from UV absorbance of methanol.

Comments – An apothecium of the holotype, with the characteristically thin, thalline exciple is illustrated in Fig. 2d. *M. valdiviensis* was regarded as a two-spored species by Räsänen (1937) and by Santesson (1942), who stated that the asci are often abortive. Calvelo & Adler (1994) and Bernasconi et al. (2002), who also treated the species, only found a few apothecia, and apparently no asci with spores, and therefore only referred to the spore size measurements provided by Santesson (1942). The holotype has two large apothecia. A minute sector was removed and studied. All asci seen were under-developed. However, the isotype has several, large apothecia, and mature asci with up to seven spores were found. Most material of *M. valdiviensis* analysed during the present study have mostly immature or abortive asci. However, some asci were seen with spores, and most of them have between three and eight spores. It is therefore concluded that *M. valdiviensis* belongs to the subgenus *Octospora*, and not to *Dispora* (cf. Santesson 1942). Since many spore initials never develop, the number of spores is generally lower than eight, and occasionally not more than two, as seen by Räsänen (1937) and Santesson (1942).

The most northerly populations of *M. valdiviensis* (Conguillío and Nahuelbuta) differ from the Valdivian populations in having numerous eight-spored asci, in having a more yellowish thallus, and in having thalline exciples that occasionally are concolorous with the discs (Fig. 1C), and not with the thallus. Usnic acid is present in these specimens in very low amounts only, and the chemical content is identical to that of the holotype. Thus, the yellow colour is not due to an increased concentration of usnic acid. In fact, thalli remained yellow even after acetone rinsing. Thus, the yellow pigments are not acetone-soluble. The yellowish thallus colour and the numerous eight-spored asci are characters reminiscent of *M. cincinnata*. However, large, plane apothecia with thin exciples (Fig. 1C), a strongly yellow-orange colour of the subhymenial medulla, trace amounts of usnic acid, and shining, non-corrugate lobes are characters that strongly indicate affiliation in *M. valdiviensis* and not in *M. cincinnata*. The slightly deviating habit of the specimens from the northerly populations may be related to life at higher altitudes (> 1000 m). Valdivian specimens are mostly collected at altitudes from 900 m and below.

Distribution and habitat ecology – In southern South America along the Cordilleras from latitude 37°40' S (Parque Nacional Nahuelbuta) to southernmost South America (probably to latitude 52° S). It grows on both trees and shrubs, often in understory vegetation, but avoiding the most low-light habitats. It is known from the following phorophytes: *Amomyrtus luma*, *A. meli*, *Araucaria araucana*, *Drimys winteri*, *Nothofagus dombeyi* and *Pseudopanax laetevirens*. No specimens of *M. valdiviensis* were found by the present author during field research in the Magellanic Region. However, Santesson (1942) cited it from one Magellanic locality, Newton Island, a small island 90 km WSW of Puerto Natales at the transition between Magellanic moorland and antiboreal rainforests (cf. map in Elvebakk & Moberg 2002). Calvelo & Adler (1994) reported it from the Argentinean part of Isla Grande, but at least some of these reports may be referable to *M. cincinnata*, as only one of the specimens was fertile. The exact southern distribution limit of *M. valdiviensis* is therefore still not known with certainty.

ADDITIONAL SELECTED SPECIMENS EXAMINED – ARGENTINA. Prov. de Río Negro. Parque Nacional Nahuel Huapí, San Leo, 1896, *P Dusén 165* (S). Parque Nacional Nahuel Huapí, Puerto Blest, Los Clavos, 29.XII.2001, *M Caldiz s.n.* (TROM). **CHILE. IX Región de la Araucana. Prov. de Malleco.** Parque Nacional Nahuelbuta, 2001, *JW Bjerke 977/01, 995/01* (TROM). **Prov. de Cautín.** Parque Nacional Conguillío, Administration Centre, 1985, *PF Cannon 13, 102* (BM). idem, 1995, *A Elvebakk 95:379* (TROM). **X Región de Los Lagos. Prov. de Osorno.** Parque Nacional Puyehue, Volcán Casa Blanca, 1985, *PF Cannon 199, 245b* (BM). **Prov. de Llanquihue.** Parque Nacional Vicente Pérez Rosales, southern slope of Volcán Osorno, 2001, *JW Bjerke 663/01, 702/01* (TROM). Parque Nacional Vicente Pérez Rosales, Petrohué, 2000, *A Elvebakk 00:582A, 00:585, 00:600* (TROM).

7. *Menegazzia wilsonii* (Vain. ex Räsänen) Bjerke *comb. nov.*

Type: Chile, Valparaíso, 1900, *Ch. E. Porter s.n.* [TUR-V 03430 (TUR 003951), lectotype here designated]. Basionym: *Parmelia wilsonii* Vain. ex. Räsänen, Ann. Bot. Soc. Zool.-Bot. Fenn. 'Vanamo' 2, 1: 17 (1932) = *Menegazzia albida* (Zahlbr.) R. Sant.; type: Chile, Seno Almirantazgo, at the mouth of Rio Azopardo, in *N. antarctica* forest, 1908, *C. Skottsberg s.n.* (UPS — lectotype, designated by Santesson, 1942: 17) □ *Parmelia cincinnata* Ach. var. *albida* Zahlbr., Kongl. Svenska Vetenskapsakad. Handl. 57, 6: 38 (1917).

Thallus firmly attached, forming small to large, orbicular rosettes, 2-15 cm wide. **Lobes** 0.8-2.0 mm wide, not much inflated, slightly concave to plane, crowded, partly overlapping, often flabellate or subdichotomously to monopodially branched, often with toe-like laterals. **Upper surface** smooth, glossy at apices, dull towards centre, slightly maculate, grey-white to pale green, becoming brown-black at older lobes, pale brown at tips, black along margins. **Perforations** numerous, many per lobe, narrowly to broadly oval or occasionally rounded, smaller at apices than at centre, 0.1-0.9 mm wide; rim plane slightly inrolled. **Soralia** and **isidia** absent. **Lower surface** black, pale brown and glossy at apices, eperforate. **Medullary cavity** white above, black below. **Apothecia** chiefly numerous, more rarely sparse or absent, rounded or oval, laminal, ±sessile to short-pedicellate, generally small, 0.6-1.5 mm wide when mature; medullary layer under hymenium white. **Disc** plane in mature apothecia, slightly concave when younger, epruinose, brown, often disintegrating or consumed by insects. **Thalline exciple** concolorous with thallus, occasionally partly blackened, entire, glossy, smooth, with a few lateral cracks, 0.1-0.2 mm wide. **Ascospores** 8 per ascus, small, hyaline, 19-29 × 12-18 μm; wall 1.5-2.5 μm. **Pycnidia** numerous; ostiole dark brown.

Chemistry – Atranorin (trace to major), chloroatranorin (trace to minor), lichesterinic and protolichesterinic acids (major), traces of additional fatty acids that may be identical to those reported from *M. jamesii* (Kantvilas & Louwhoff 2004), viz. isonephrosterinic and homolichesterinic acids.

Comments – Santesson (1942) stated that *P. wilsonii* belongs to *M. albida pro parte*. On the same line as the species name, Räsänen (1932) listed two specimens, no. 3430 and 3431, from Vainio's herbarium. These are here regarded as syntypes, whereas Roivainen's collections, listed at the end of the species treatment merely by their locality names, are regarded as paratypes. Both syntypes, each containing one thallus glued to a paper card, were examined. No. 3430 is annotated 'ex. orig.'. Räsänen (1932) stated that "Exemplar originale in Herb. Vainio est ster[ile].", but that is not correct. It has two small apothecia, most certainly without mature asci (Fig. 4e). These structures were probably overlooked by Räsänen. It is natural to select this specimen as lectotype. Also the other syntype has a few, young, immature apothecia. They share the same morphology and chemistry and are identical with specimens identified as *M. albida* by Santesson (1942), among others two of the paratypes of *P. wilsonii*, which were studied for the present account. The lectotype of *M. albida* was not available, but the other syntype cited by Zahlbruckner (1917; "Westende des Lago Fagnano", label in Swedish saying "vestenden av Lago Fagnano") was seen. The conclusion from studying the type material and other material is that these two taxa are conspecific, and since *P. wilsonii* is the earliest legitimate name at species rank, it is given priority (Art. 11.3). The Lago

Fagnano syntype has a label with the text "*Menegazzia wilsonii* (…) determ. RS 1946". Thus, R. Santesson also realized that *M. wilsonii* has priority, but he never formally made the new combination.

Kantvilas & Louwhoff (2004) discussed whether *M. wilsonii* (as *M. albida*) is conspecific with *M. pertransita* (Stirt.) R. Sant. They both have eight-spored asci and protolichesterinic and lichesterinic acids as major medullary constituents. Although they are anatomically and chemically similar, some morphological characters distinguish the two species. *M. pertransita* is a larger species, having broad, convex lobes with rounded perforations, larger, cupuliform, pedicellate apothecia with areolate-striate margins and coarsely scabrid exciples, and numerous dark-red pycnidia. The spores also tend to be larger than those of *M. wilsonii*. Moreover, *M. pertransita* regularly has yellow pigments, viz. eumitrins and/or secalonic acid derivatives (Kantvilas & Louwhoff 2004), in the upper surface of the medullary cavity, whereas *M. wilsonii* is never yellow-pigmented. Thus, they are therefore not conspecific. Specimens of *M. wilsonii* with numerous, elongate, oval perforations are in fact morphologically more similar to the highly characteristic, Tasmanian species *M. myriotrema* (Müll. Arg.) P. James, which is recognized by the high density of irregularly shaped perforations. However, *M. myriotrema* is a two-spored species with the stictic acid complex in the medulla, and is generally more densely perforate than *M. wilsonii*.

Distribution and habitat ecology – In southern South America along the Cordilleras from latitude 36°50' S (Termas de Chillán) to the southernmost part of Tierra del Fuego. The lectotype is annotated "Valparaíso". My own field research in the areas around Valparaíso in Central Chile (including high-altitude areas in Parque Nacional La Campana) did not lead to any findings of *Menegazzia*, and the forested areas around the city are considered too warm and dry for *M. wilsonii* and Chilean species of *Menegazzia* in general. Thus, it may be that the collector of the lectotype used the name Valparaíso in a much wider sense than presently used, including areas to the south from where *M. wilsonii* is known through recent collections. *M. wilsonii* is a common epiphyte throughout its distribution range. It prefers trunks and twigs of *Araucaria araucana*, *Austrocedrus chilensis*, *Drimys winteri*, *Embothrium coccineum*, *Fitzroya cupressoides*, *Gevuina avellana*, *Nothofagus antarctica*, *N. betuloides*, *N. dombeyi*, *N. nitida*, *Podocarpus andinus*, and probably numerous other phorophytes. It is common both in shady and more light-open rainforests. It is less common in drier forests east of the rainforests. For example, it was not found in the *Nothofagus pumilio* forests of the Magellanic Region.

ADDITIONAL SELECTED SPECIMENS EXAMINED –– ARGENTINA. Prov. de Río Negro. Parque Nacional Nahuel HUAPÍ, Puerto Blest, Las Cantaras, 30.I.2002, *M Caldiz s.n.* (TROM). Parque Nacional Nahuel HUAPÍ, Puerto Blest, southern shore of Brazo Puerto Blest, 1983, *P Ranta 2015* (H). Parque Nacional Nahuel HUAPÍ, Isla Victoria, 1950, *IM Lamb 5838* (UPS). **Prov. de Tierra del Fuego.** Isla Grande, vestenden av Lago Fagnano, 9.III.1908, *C Skottsberg s.n.* (UPS-syntype of *Parmelia cincinnata* var. *albida*). **CHILE.** Exact locality not known, "Patagonia occid., Près de Cordillere le long du Rio Ansca (?)" [Río Aisén ?], IV.1900, *Excursion de MB Wilson s.n.* [TUR-V 03431 (TUR 003883)-syntype]. **IX Región de la Araucana. Prov. de Malleco.** Parque Nacional Nahuelbuta, Piedra del Águila, 2001, *JW Bjerke 994/01, 996/01* (TROM).

idem, 1948, *B Sparre 5086* (S). **Prov. de Cautín.** Parque Nacional Conguillío, Cabañas La Baita, 2001, *JW Bjerke 1434/01 & DJ Galloway s.n.* (TROM). Parque Nacional Conguillío, near upper lake, 1985, *PF Cannon 78* (BM 000761547). Parque Nacional Villarica, NW slope of volcano, 1972, *PW Rundel 7458* (BM). **X Región de Los Lagos. Prov. de Osorno.** Parque Nacional Puyehue, 5 km from Antillanca, 1986, *BJ Coppins et al. 4426* (BM). **Prov. de Valdivia.** 8.4 km SW of Choshuenco, 1986, *BJ Coppins et al. 6492* (BM). **Prov. de Llanquihue.** Parque Nacional Vicente Pérez Rosales, c. 1.5 km N of Petrohué, 2001, *JW Bjerke 515/01, 609/01* (TROM). Parque Nacional Vicente Pérez Rosales, southern slope of Volcán Osorno, 2001, *JW Bjerke 734/01* (TROM). **XI Región Aisén del General Carlos Ibañez del Campo. Prov. de Capitán Prat.** Parque Nacional Laguna San Rafael, 1997, *W Quilhot 1455* (TROM). El Vagabundo, 100 km S of Cochrane, 2002, *W Quilhot 3071* (UV). **XII Región de Magallanes. Prov. de Última Esperanza.** Patagonian Channels, Puerto Bueno, 1969, *H Imshaug 44560 & K Ohlsson* (GZU). Parque Nacional Bernardo O'Higgins, 0.5 km WSW of Glacier Serrano, 1998, *JW Bjerke 236/98* (TROM), *244/98, 251/98* (UV). Fiordo Andrew, 1985, *A Newton L87a* (BM). **Prov. de Magallanes.** Península Brunswick, 5 km N of San Isidro, 1999, *A Elvebakk 99:1222* (TROM). **Prov. de Tierra del Fuego.** Isla Grande, Fiordo Finlandia, 28.II.1929, *H Roivainen s.n.* (H). SE point of Isla Williams, 1969, *H Imshaug 43452 & K Ohlsson* (BM).

The sorediate species

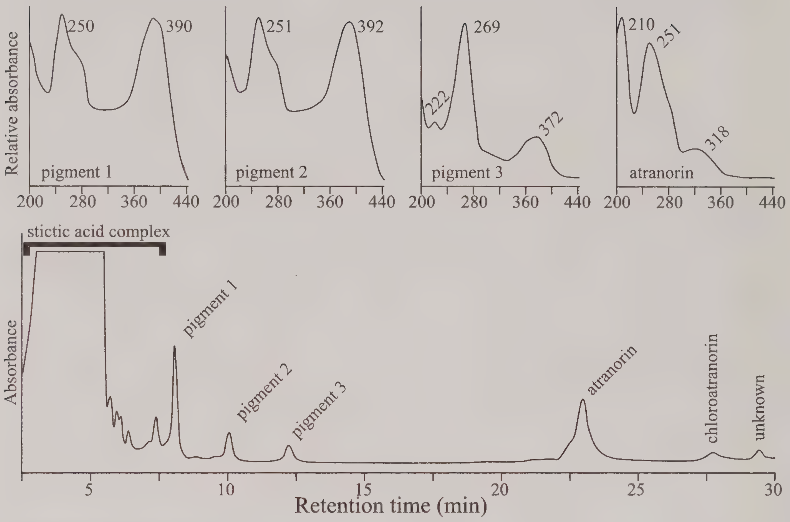
8. *Menegazzia chrysogaster* Bjerke & Elvebakk

Mycotaxon 78: 371 (2001); type: Chile, IX Región de la Araucana, Provincia de Malleco, Malalcahuello, 12.X.1987, *W Quilhot 2004* (S ! — holotype; UV ! — isotype).

Comments – *Menegazzia chrysogaster* is characterized by convex soralia; a greyish green upper surface; slightly pruinose and maculate lobe tips; and yellow-orange unidentified pigments in the hyphae of the upper surface of the medullary cavity. It contains atranorin (minor to major), chloroatranorin (trace to minor), stictic acid (major), cryptostictic acid (trace to minor), constictic acid (major), menegazziaic acid (trace to minor) and unidentified yellow-orange pigments (see below). It is a southern South American endemic known from latitude 36°50' S to Isla de los Estados.

Bernasconi et al. (2002) reported *M. caliginosa* P. James & D. J. Galloway from Argentina. The Argentinean specimens on which they based their report were here compared with *M. chrysogaster* and with *M. caliginosa* from Australasia (including the holotypes). The Argentinean specimens differ both morphologically and chemically from *M. caliginosa*, but are identical to *M. chrysogaster*. The distinguishing morphological characters are maculate and pruinose lobes in *M. chrysogaster* and shining, epruinose and emaculate lobe tips in *M. caliginosa*. Moreover, the yellow-orange pigments in *M. caliginosa* are located on both surfaces of the medullary cavity, giving the lower side a dirty-ochre tint towards central parts of lobes, whereas the yellow-orange pigments in *M. chrysogaster* are located only on the upper surface of the medullary cavity, and the colour is generally less intense in the latter species. In addition, as reported by Bjerke & Elvebakk (2001) and further evidenced here by HPLC analyses, the two species do not produce the same yellow-orange pigments (Fig. 7). According to their UV spectra, the pigments belong to different chemical groups. Some are similar to anthraquinones (absorption maxima at longer wavelengths), but are different from those detected in

a) *Menegazzia chrysogaster*



b) *Menegazzia caliginosa*

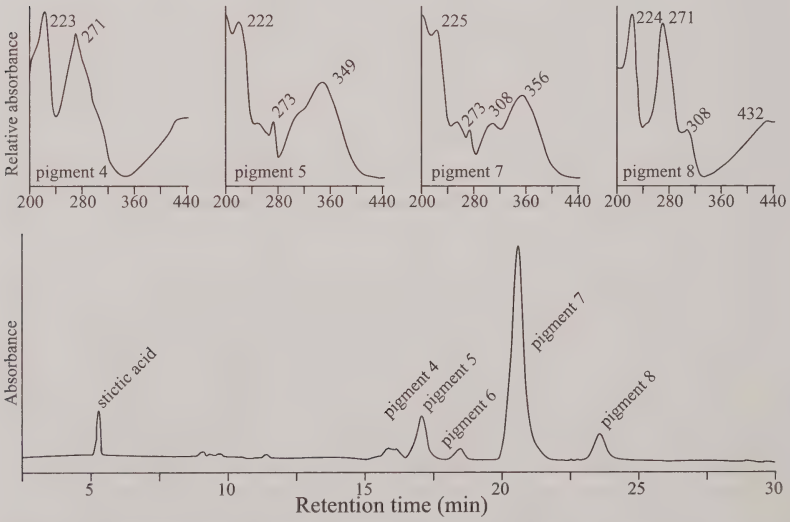


Fig. 7. HPLC chromatograms of acetone extracts of a) *Menegazzia chrysogaster* (*W. Quilhot 3070*) and b) *M. caliginosa* (*GE & G Du Rietz 1462:2*). Different yellow-orange pigments were detected in the two species. Pigments in *M. chrysogaster* are called "pigment 1-3", whereas pigments in *M. caliginosa* are called "pigment 4-8". UV spectra are provided for atranorin and 7 of the eight pigments. Pigment 6 has almost identical spectrum as pigment 7, and is not shown. See text for more information.

M. cincinnata and *M. valdiviensis*. While *M. chrysogaster* has three pigments with retention times between 8.0 min and 12.2 min, *M. chrysogaster* has five pigments with retention times between 15.9 min and 23.6 min. Since the yellow pigments are confined to the upper surface of the medullary cavity in *M. chrysogaster*, they are difficult to separate from white, stictic acid-containing medullary tissue. Therefore, large peaks of stictic acid and constictic acid and smaller peaks of menegazziaic acid, cryptostictic acid and other satellite compounds appear in the initial phase of the chromatogram. In *M. caliginosa*, it is possible to do analyses on yellow-orange hyphae from the lower surface of the medullary cavity, and as seen in the chromatogram (Fig. 7b), only minor traces of stictic acid was detected in this part of the thallus. Based on the morphological and chemical evidence given here, the report of *M. caliginosa* from southern South America is rejected.

ADDITIONAL SELECTED SPECIMENS EXAMINED – ARGENTINA. Prov. de Tierra del Fuego. Ushuaia, base del Glaciar Martial, 1993, *S Calvelo & MT Adler s.n.* (BAFC 37719, BAFC 37682, BAFC 37684). Bajada del Glaciar Martial, 1993, *S Calvelo & MT Adler s.n.* (BAFC 37505). Isla Grande, alrededores de Hostería Petrel, 1993, *S Calvelo & MT Adler s.n.* (BAFC 37643). **CHILE. XI Región Aisén del General Carlos Ibañez del Campo. Prov. de Capitán Prat.** El Vagabundo, 100 km S of Cochrane, 2002, *W Quilhot 3070* (UV). **SPECIMENS OF *M. caliginosa* ANALYSED BY HPLC – NEW ZEALAND. Canterbury.** Cass, 1927, *G Du Rietz 1462:2* (UPS). **Otago.** Kinloch, 1927, *G Du Rietz 1965d* (UPS).

9. *Menegazzia fumarprotocetrarica* Calvelo & Adler

Mycotaxon 59: 369 (1996); type: Argentina: Prov. de Río Negro, Bariloche, Llao Llao, 7.X.1993, *S Calvelo 37861* (BAFC — holotype).

Comments – *Menegazzia fumarprotocetrarica* is characterized by soralia formed on 1-2 mm tall pustules, small perforations with flat or slightly elevated rims and the presence of fumarprotocetraric acid in the medulla. It also contains atranorin (minor to major). It is known from southern South America along the Andean and coastal mountain ranges from latitude 37°40' to Tierra del Fuego (see under *M. kawesqarica* for an additional specimen examined). A sorediate, fumarprotocetraric acid-containing species similar to *M. fumarprotocetrarica* was recently described from New Zealand as *M. hypernota* Bjerke (Bjerke 2004a).

10. *Menegazzia globulifera* R. Sant.

Ark. Bot. 30A, 11: 30 (1942); type: Tierra del Fuego, Estancia Carmen, Puesto Millaldeo, 16.I.1929, *H Roivainen s.n.* (S — holotype).

Comments – *Menegazzia globulifera* is characterized by vesicular, helmet-shaped soralia; a yellow-green, shining upper surface; and usnic acid in the upper cortex. It is discussed in detail in Santesson (1942), James (1985) and James & Galloway (1992). It contains usnic acid (minor to major) and lecanoric acid (major). In addition, HPLC analyses of material both from New Zealand (*A. Elvebakk* 02:602, TROM) and Chile (*A. Elvebakk* 95:269) revealed minor amounts of the unidentified substance Unid. 1, which also was detected in *M. cincinnata* and *M. valdiviensis* (see above). Unid. 2 was not detected in *M. globulifera*. In southern South America, it is known from latitude 36°50' S to Tierra del Fuego.

11. *Menegazzia kawesqarica* Bjerke & Elvebakk

Mycotaxon 78: 376 (2001); type: Chile, Región XII de Magallanes y de la Antárctica Chilena, Provincia de Magallanes, Morro Chico, in the central depression of the volcanic rock outcrop, 52°03'S - 71°28'W, on a vertical southfacing cliff surface, 220 m alt, 28.XI.1999, *A Elvebakk 99:875* (S ! — holotype, HO !, TROM !, UV ! — isotypes).

Comments – *Menegazzia kawesqarica* is characterized by large, convex, partly confluent soralia; a matt, greyish, patchily blackened and corrugate upper surface; and wide, slightly convex, maculate lobes. It contains atranorin (minor to major), chloroatranorin (minor), stictic acid (major), constictic acid (major), cryptostictic acid (trace to minor) and menegazziaic acid (trace to minor). It is endemic to southern South America being known from latitude 37°50' S to Tierra del Fuego. It is most common in the southern part of its distribution area.

Menegazzia subbullata P. James & Kantvilas, an Australian-Tasmanian species recognized by its inflated, shining, sausage-like lobes with soralia often arising from perforation rims (James & Galloway 1992), was reported from Argentina by Bernasconi et al. (2002). Two of their collections were studied here. One collection proved to be an admixture of *M. fumarprotocetrarica* and *M. kawesqarica* (BAFC 37718), whereas the other is in its entirety *M. kawesqarica* (BAFC 37645). *M. kawesqarica* is also chemically distinct from *M. subbullata*, as the latter species produces some unidentified substances that fluoresce strongly when exposed to UV-A radiation. No fluorescent substances were found in any specimens from Chile or Argentina. The report of *M. subbullata* from Argentina is therefore rejected.

ADDITIONAL SELECTED SPECIMENS EXAMINED – **ARGENTINA. Prov. de Tierra del Fuego.** Ushuaia, bajada de Glaciar Martial, 1993, *S Calvelo & MT Adler s.n.* (BAFC 37645). Base del Glaciar Martial, 1993, *S Calvelo & MT Adler s.n.* (BAFC 37718-mixed with *M. fumarprotocetrarica*).

12. *Menegazzia magellanica* R. Sant.

Ark. Bot. 30A, 11: 23 (1942); type: Patagonia, Punta Arenas [Chile], XI.1895, *P Dusén 4b* (S ! — holotype, UPS — isotype).

Comments – *Menegazzia magellanica* is characterized by a greyish-green upper surface; matt, slightly pruinose and maculate lobes; circular perforations with plane rims; and cuff-like (maniciform) soralia with an open duct to the medullary cavity. It contains atranorin (major), chloroatranorin (minor), stictic acid (major), constictic acid (major), cryptostictic acid (trace to minor) and menegazziaic acid (trace to minor). It is distributed in southernmost South America south of latitude 50°50' S on South Georgia (Bjerke & Elvebakk 2001, Bjerke 2004b), and the Falkland Islands. This is the first report of *M. magellanica* from the Falkland Islands.

Menegazzia kantvilasii P. James was reported from Argentina by Bernasconi et al. (2002). This rare Tasmanian species is characterized by numerous, contiguous, shining, occasionally faveolate lobes; numerous perforations with elevated, conical rims; numerous, laminal pustules from which lacerate, hooded soralia arise; and stictic and fatty acids in the medulla. James & Galloway (1992) stated that *M. kantvilasii* is similar to *M. magellanica*, but they also stated that the latter species contains thamnolic acid, which it does not. They instead compared *M. kantvilasii* with *M. wandae* (Bjerke 2001).

The specimens reported as *M. kantvilasii* by Bernasconi et al. (2002) are well within the range of variability seen in *M. magellanica*, and differ from *M. kantvilasii* in several respects, for instance in the lack of pustules with hooded soralia and fatty acids in the medulla. The report of *M. kantvilasii* from Argentina is therefore rejected.

ADDITIONAL SELECTED SPECIMENS EXAMINED – **ARGENTINA. Prov. de Tierra del Fuego.** Cabecera Lago Fagnano, 1993, *S Calvelo & MT Adler s.n.* (BAFC 37721). Ushuaia, bajada de Glaciar Martial, 1993, *S Calvelo & MT Adler s.n.* (BAFC 37642, BAFC 37644, BAFC 37697). **FALKLAND ISLANDS. West Falklands.** Port Howard, Freezer Rocks, 1968, *HA Imshaug 41351 & RC Harris* (GZU).

13. *Menegazzia neozelandica* (Zahlbr.) P. James

Fl. Australia 54: 313 (1992); type: New Zealand, near Wellington, *J Buchanan* 13 (BM ! — holotype) ≡ *Parmelia neozelandica* Zahlbr., Cat. Lich. Univ. 6: 53 (1930) ≡ *Parmelia nigrescens* Stirt., Scott. Nat. 4: 253 (1878) nom. illeg. (Art. 53.1) ≡ *Menegazzia nigrescens* (Stirt.) R. Sant., Ark. Bot. 30A, 11: 13 (1942) = *Parmelia opuntioides* Müll. Arg. var. *vulgaris* Räsänen, Ann. Bot. Soc. Zool.-Bot. Fenn. 'Vanamo' 2, 1: 18 (1932); type: Fuegia, Pto. Arturo [Chile], and der Rinde d. *Nothofagus*, 6.III.1929, *H Roivainen s.n.*, thallus glued to paper card "3" (H ! — lectotype designated here) = *Menegazzia circumsorediata* R. Sant., Ark. Bot. 30A, 11: 14 (1942); type: New Zealand, South Island, Fiord. Bot. Distr., Doubtful Sound, Deep Cove, 4.III.1927, *GE & G Du Rietz 2075: 1* (S ! — holotype).

Note: In his treatment of *P. opuntioides*, Räsänen (1932) stated "Apothecia desunt. — Est var. *vulgaris* Räs. (nova)". On the next lines, he listed two localities, Fiordo Finlandia and Isla Clarence, but it is not clear whether these refer to *P. opuntioides* var. *opuntioides* or to var. *vulgaris*. No specimens of var. *vulgaris* from any of the two localities were found during the preparation of the present account, and it is therefore suggested here that the two locality names refer to localities of var. *opuntioides*. One collection from Puerto Arturo identified to var. *vulgaris* by Räsänen was found. It consists of two thalli; the largest is attached to a paper card and is a typical *M. neozelandica*, and the smallest is a loose thallus fragment of *M. wilsonii*, which in turn is overgrown by an even smaller thallus of an unidentified, sorediate species of *Menegazzia*. The largest thallus is here selected as lectotype of *P. opuntioides* var. *vulgaris*.

Comments – *Menegazzia neozelandica* is characterized by a convex, glossy upper surface; numerous gaping perforations with elevated rims; and slightly elevated soralia that mainly surround the perforations (James & Galloway 1992, Calvelo & Adler 1994, Bjerke & Elvebakk 2001, Bjerke et al. 2003a). It contains atranorin (minor to major), chloroatranorin (minor), stictic acid (major), cryptostictic acid (minor), constictic acid (major) and menegazziaic acid (minor). In South America, it is known from latitude 30°30' S (Parque Nacional Fray Jorge) to Tierra del Fuego, but with a lacuna between Fray Jorge and Lago Lleu-Lleu at latitude 38°10' S. It is also present on Islas Juan Fernández.

14. *Menegazzia sanguinascens* (Räsänen) R. Sant.

Ark. Bot. 30A, 11: 28 (1942); type: Tierra del Fuego, Fiordo de Agostini, 1929, *H Roivainen s.n.* (H! — lectotype, designated by Santesson, 1942: 29) ≡ *Parmelia sanguinascens* Räsänen, Ann. Bot. Soc. Zool.-Bot. Fenn. 'Vanamo' 2, 1: 18 (1932) = *Menegazzia norsorediata* Adler & Calvelo, Mycotaxon 59: 368 (1996); type: Argentina: Prov. de Tierra del Fuego, 10 km from the intersection of Moat River and the route from Moat to Ushuaia, XI.1993, *S Calvelo & MT Adler s.n.* (BAFC 37732 — holotype).

Comments – The use of the term holotype for the type of *M. sanguinascens* by Bjerke & Elvebakk (2001) and Bjerke et al. (2003a) is incorrect, as Räsänen (1932) did not designate any particular type for *Parmelia sanguinascens*. Räsänen (1932) cited four localities, all from Isla Grande, viz. Río Bueno, Fiordo Finlandia, Fiordo de Agostini and Fiordo Almirante Martínez. Santesson (1942) selected the collection from Fiordo de Agostini as lectotype and cited three herbaria; H, S and Räsänen's personal herbarium. The H specimen is annotated "Typus!". The S specimen is not annotated "Typus" or anything similar. Thus, the H specimen must be regarded as the lectotype. The lectotype was unavailable until recently. Thus, taxonomic conclusions on *M. sanguinascens* in Bjerke & Elvebakk (2001) and Bjerke et al. (2003a) are based on the identity of the Fiordo de Agostini specimen housed in S (the "isolectotype"). The lectotype proved to be different from the S specimen. While the S specimen contains hypothamnolic acid, the lectotype contains norstictic acid and is morphologically and chemically identical with *M. norsorediata*. Räsänen (1932) stated that *P. sanguinascens* is "K+ rubescentes", viz. K+ reddish, and therefore probably also gave it the epithet meaning "becoming blood-red". A taxon described by Räsänen (1932) that subsequently proved to contain hypothamnolic acid is *P. opuntioides* var. *violascens*. Räsänen stated that the soredia of this taxon reacts "K+ violascentia". It is observed that the KOH reaction of hypothamnolic acid is more violet than the reddish reaction of norstictic acid (cf. Huneck & Yoshimura 1996). Thus, the description of *P. sanguinascens* certainly refers to the norstictic acid-containing taxon, although some of the syntypes do not contain norstictic acid. Santesson (1942) had a broad view of *M. sanguinascens*, including specimens with quite different chemistry and morphology (see also Bjerke & Elvebakk 2001). This finding leads to nomenclatural changes. *M. norsorediata* is placed as a synonym of *M. sanguinascens*. Consequently, there are no existing names at species level for the hypothamnolic acid-containing taxon. Räsänen's taxon *P. opuntioides* var. *violascens* is therefore resurrected and raised to species level (see below).

Menegazzia sanguinascens is characterized by greyish-green, slightly shining, epruinose, slightly maculate lobes, evenly distributed perforations with flat or elevated rims, and convex, well-separated soralia with orange patches. For full descriptions, see descriptions of *M. norsorediata* by Adler & Calvelo (1996), Bjerke & Elvebakk (2001), Bernasconi et al. (2002) and Bjerke et al. (2003a). It contains atranorin (minor to major), chloroatranorin (absent to minor), norstictic acid (major) and connorstictic acid (trace to minor). It is a southern South American endemic known from latitude 37°40' S (Nahuelbuta) to Tierra del Fuego. It becomes rarer towards the south. Filson's (1981, 1996) reports of *M. sanguinascens* from Macquarie Island are incorrect and referable to *M. subpertusa* (Bjerke 2004b).

15. *Menegazzia subpertusa* P. James & D. J. Galloway

New Zealand J. Bot. 21: 195 (1983); type: New Zealand, Wellington, Rangitikei Gorge, On *Leptospermum*, 17.VI.1980, *JK Bartlett s.n.* (BM — holotype, CHR — isotype).

Notes: *Parmelia pertusa* var. *coskinodes* Wilson and *Parmelia pertusa* var. *montana* Wilson, both described from Tasmania (Wilson 1893), may be conspecific with *M. subpertusa*, but authentic material was not seen.

Comments – *Menegazzia subpertusa* is characterized by a closely attached thallus; convex, irregularly spreading and often imbricate lobes; small perforations with flat rims; laminal, convex, more or less clustered soralia; and apothecia with two-spored asci. It contains atranorin (minor to major), chloroatranorin (trace to minor), stictic acid (major), menegazziaic acid (trace to major), cryptostictic acid (trace to major) and constictic acid (minor to major). It is known from latitude 36°50' S to Isla de los Estados (54°50' S), but with a wide disjunction in southern Chile.

ADDITIONAL SPECIMEN EXAMINED – CHILE. X Región de Los Lagos. Prov. de Llanquihue. Parque Nacional Vicente Pérez Rosales, Río Petrohué, near falls, 1986, *BJ Coppins et al. 5188* (BM).

16. *Menegazzia subsimilis* (H. Magn.) R. Sant.

Ark. Bot. 30A, 11: 13 (1942); type: Hawaii, Kauai, Lehua makanoe [Lihue Makahuena], on *Wikstroemia*, 15.VIII.1938, *LM Cranwell, O Selling & C Skottsberg 6034* (UPS ! — holotype) ≡ *Parmelia subsimilis* H. Magn., Ark. Bot. 30B, 3: 5 (1941) = *M. pertusa* f. *dissecta* Rass., Nov. Sist. Niz. Rast. 1: 247 (1964); type: Russia, Oriens extremus, Sichote-Alinj austr., publicum reservatum Sudzuchinskij, 29.VI.1944, *Zhudova & Pokrovskaja* (LE ! — holotype) ≡ *M. terebrata* var. *dissecta* (Rass.) Poelt, Bestimmungsschl. eur. Flechten: 756 (1969)≡ *M. pertusa* var. *dissecta* (Rass.) Rass., Nov. Sist. Niz. Rast. 10: 198 (1973) ≡ *M. dissecta* (Rass.) Hafellner, Fritschiana 12: 18 (1997).

Comments – *Menegazzia subsimilis* is characterized by lacerate, slightly elevated soralia; numerous, small perforations with flat rims; and a glossy, epruinose surface. It contains atranorin (major), chloroatranorin (minor to major), stictic acid (major), constictic acid (major), cryptostictic acid (minor) and menegazziaic acid (minor to major). It is known from three localities in South America; one in Ecuador (Bjerke 2003), and two in Peru, viz. the one reported by Bjerke (2002) and the one reported here.

ADDITIONAL SPECIMEN EXAMINED – PERU. Depto. San Martín. Sine Loco, 1965, *PM Holligan L87* (BM).

17. *Menegazzia tenuis* R. Sant.

Ark. Bot. 30A, 11: 27 (1942); type: Tierra del Fuego, Isla Desolación, Puerto Angosto [Chile], 12.IV.1896, *P Dusén 228a* (S ! — holotype, UPS — isotype).

Comments – *Menegazzia tenuis* is characterized by narrow, ± concave lobes; numerous, ellipsoid to oval perforations; and small, maniciform soralia containing few soralia. It contains atranorin (minor to major), chloroatranorin (trace to minor), lichesterinic acid (minor to major) and protolichesterinic acid (minor to major). It is known from southernmost South America south of latitude 52°40' S and from a single locality in Region IX at 1400 m alt.

ADDITIONAL SPECIMEN EXAMINED – CHILE. XII Región de Magallanes. Prov. de Magallanes. Isla Furia, eastern part, 1987, *S Stenroos 2643* (H).

18. *Menegazzia terebrata* (Hoffm.) A. Massal.

Neag. Lich.: 3 (1854) ≡ *Lobaria terebrata* Hoffm., Deutsch. Fl. oder Bot. Taschenb. Zweyter Theil für das Jahr 1795 Cryptog., B.I.I.: 151 (1796); probably not typified = *Lichen pertusus* Schrank, Bayer. Fl. 2: 519 (1789) nom illeg. For additional synonyms, see Zahlbruckner (1930).

Comments – *Menegazzia terebrata* is characterized by closely attached thallus rosettes; narrow, contiguous, shining, epruinose lobes; and small, convex, occasionally perforated soralia. It contains atranorin (major), chloroatranorin (minor to major), stictic acid (major), constictic acid (major), cryptostictic acid (minor) and menegazziaic acid (minor to major). In South America, it is so far only known from a few localities in Colombia, Ecuador and Venezuela (Bjerke 2002).

19. *Menegazzia violascens* (Räsänen) Bjerke *stat. et comb. nov.*

Type: Fuegia [Tierra del Fuego], Pto. Arturo [Chile], ad *Nothofagus*, 6.III.1929, *H Roivainen s.n.* (H ! — lectotype designated here, S ! — duplicate of lectotype, i.e. "isolectotype"). Basionym: *Parmelia opuntioides* Müll. Arg. var. *violascens* Räsänen, Ann. Bot. Soc. Zool.-Bot. Fenn. 'Vanamo' 2, 1: 18 (1932) ? = *Parmelia dispora* var. *alboffii* Zahlbr., Kongl. Svenska Vetenskapsakad. Handl. 57, 6: 39 (1917); type: Tierra del Fuego, Seno Almirantazgo, at the mouth of Rio Azopardo [Chile], 1908, *C Skottsberg* (UPS — lectotype designated by Santesson, 1942: 29) ≡ *Parmelia alboffii* (Zahlbr.) Du Rietz ex R. Sant., Ark. Bot. 30A, 11: 28 (1942).

Note: The lectotype of *P. dispora* var *alboffii* and the other syntype cited by Zahlbruckner (1917) were not seen. Thus, its synonymy with *M. violascens* is not confirmed. It may also be a synonym of *M. sanguinascens*. The original spelling is *alboffi*, but in conformity with Art. 60.11 and Rec. 60C.1, it is to be corrected to *alboffii*, as was done by Santesson (1942).

Comments – *Menegazzia violascens* is characterized by broad, shining, emaculate lobes; few to numerous toe-like lateral branches; and neat, convex soralia that are UV+ white and K+ violet. As stated above, the sorediate, hypothamnolic acid-containing taxon in southern South America was erroneously considered to be *M. sanguinascens* by Calvelo & Adler (1994), Bjerke & Elvebakk (2001), Bernasconi et al. (2002), Quilhot et al. (2002) and Bjerke et al. (2003a), see the treatments of *M. sanguinascens* in these references for a full description of *M. violascens*. It contains atranorin (minor to major), chloroatranorin (minor), hypothamnolic acid (major) and thamnolic acid (trace to minor).

Distribution – In Chile and Argentina south of 37°40' S and on Islas Juan Fernández. Santesson (1942) reported *M. sanguinascens* from Juan Fernández. All specimens from that archipelago seen by Bjerke et al. (2003a) proved to be *M. neozelandica*, and the occurrence there of *M. sanguinascens* sensu Calvelo & Adler (= *M. violascens*) was therefore considered doubtful. Subsequently, one of the specimens cited from the islands by Santesson (1942) was seen, and it is a typical *M. violascens*.

ADDITIONAL SPECIMEN EXAMINED – CHILE. V REGIÓN DE VALPARAÍSO. JUAN FERNÁNDEZ: MASAFUERA [ISLA ALEJANDRO SELKIRK], CORDÓN DE BARRIL, 1.III.1917, *C & I Skottsberg s.n.* (UPS).

20. *Menegazzia wandae* Bjerke

Lichenologist 33: 117 (2001); type: Chile, X Región de Los Lagos, Valdivia, Cordillera Pelada, en bosque de raulí [*Nothofagus alpina*], 19.XII.1977, *W Quilhot 1815* (UV ! — holotype, TROM ! — isotype).

Comments – *Menegazzia wandae* is characterized by convex, wide-angled lobes; prominently brown-black margins, and tall, sorediate pustules with flange-like lacerations. It contains atranorin (major to minor), chloroatranorin (minor to trace) and thamnolic acid (major). It is a Chilean endemic known from latitude 38°30' S (Malalcahuello) to latitude 46°40' S (Laguna San Rafael).

Phytogeography

In total, 20 species of *Menegazzia* are known from South America. Of these, 17 are confined to southern South America, and three to the Neotropics, and these two regions do not have any species in common. Only three of the 17 southern South American species (17.6 %) are also known from Australasia. All these species are sorediate (*M. globulifera*, *M. neozelandica* and *M. subpertusa*). The endemic element in the mycobiota of *Menegazzia* of southern South America is pronounced (82.4 %), including *M. magellanica*, which reaches South Georgia. In comparison, 72.2 % of the southern South American species of *Pseudocyphellaria* are endemic (Galloway 1992, including a recently described Chilean species; Bjerke et al. 2003b). The same ratios for some other genera with good biogeographical data are 5.0 % in *Bunodophoron* (Wedin 1995), 25.0 % in *Neuropogon* (Walker 1985), 33.3 % in *Leptogium* (Galloway & Jørgensen 1995), 50.0 % in *Sticta* (Galloway 1994), and 67.7 % in *Nephroma* (White & James 1988). Thus, *Menegazzia* has among the highest endemicity ratios of austral lichen genera in southern South America. *Menegazzia* is therefore assumed to be a genus of active, ongoing diversification.

Key to the species

1. Thallus without soralia; apothecia common 2
   Thallus with soralia; apothecia rare 9

2. Lobes multiply segmented with numerous, globose to broadly ellipsoid lobe segments; barbatic acid in medulla . . . . **M. opuntioides**
   Lobes not segmented; lobe width even; fatty acids or other depsides than barbatic acid present in medulla 3

3. Asci 2-spored; spores large, longer than 35 μm, often up to 95 μm long 4
   Asci 8-spored, or with variable numbers of spores from 1 to 8 and then often associated with underdeveloped asci; spores small, shorter than 30 μm 7

4. Lobes wide, 1.5-3.5 mm wide, convex, greyish, loosely attached; apothecia large, 3-9 mm wide; hypostictic acid complex in medulla . . . . **M. dispora**
   Lobes narrow, 0.5-1.8 mm wide, flat or slightly concave, greyish or brownish, firmly attached; apothecia small, to 2.0 mm wide; stictic acid complex in medulla 5

5. Lobes often dark brownish, especially towards tips; lobe tips dull, often slightly pruinose; perforations few, sometimes almost absent; southern South America . . . . **M. megalospora**
   Lobes grey-green, occasionally pale brown towards tips; lobe tips shining, epruinose; perforations few to numerous; the Neotropics 6

6. Apothecia unevenly oval; margins of apothecia inrolled, partly obscuring the disc; pedicel fluted with ridges .... ***M. neotropica*** **ssp.** ***neotropica***

Apothecia rounded, disc visible; pedicel not much fluted with ridges .... ***M. neotropica*** **ssp.** ***rotundicarpa***

7. Lobes grey to greyish-green, sometimes dark brown towards centre, short, imbricate; perforations oval to elongate; medulla in apothecia white; lichesterinic and protolichesterinic acids in medulla .... ***M. wilsonii***

Lobes greenish, yellowish-green or distinctly yellow, not much greyish, not brownish towards centre, long, radiating; perforations rounded to broadly ellipsoid; medulla in apothecia yellow-orange or white; lecanoric acid in medulla 8

8. Thalline exciples of young apothecia crenulate and slightly corrugate; lobes distinctly yellow or yellow-green (paler in shade forms); asci well-developed, 8-spored .... ***M. cincinnata***

Thalline exciples of young apothecia thin, smooth and not crenulate; lobes greenish or yellow-green; asci often underdeveloped, with 0-8 spores .... ***M. valdiviensis***

9. Soralia derived from ± inflated vesicles or in helmet-shaped extensions of the lobes; lobes yellow-green; usnic acid in upper cortex .... ***M. globulifera***

Soralia not vesicular in origin; lobes greyish or greyish-green; atranorin in upper cortex 10

10. Soralia predominantly associated with perforations; stictic acid complex in medulla .... ***M. neozelandica***

Soralia not, or only in exceptional cases associated with perforations; stictic acid complex present or absent 11

11. Soralia maniciform or derived from pustules, normally showing an open duct to the medullary cavity 12

Soralia convex to subcapitate, only rarely with an open duct to the medullary cavity 16

12. Soralia formed on 1-3 mm tall pustules; tip of pustules lacerate or convex ... 13

Soralia not raised substantially above the upper surface; lobes not pustulate ... 15

13. Pustules with a well-defined, convex, sorediate apex; fumarprotocetraric acid in medulla .... ***M. fumarprotocetrarica***

Pustules lacerate, not convex; stictic acid complex or thamnolic acid in medulla 14

14. Soralia moderately to extremely lacerate; lacerations long, often curling outwards, exposing their white, lower side; stictic acid complex in medulla; the Neotropics .... ***M. subsimilis***

Soralia moderately lacerate; lacerations short, not curling outwards; thamnolic acid in medulla; Chile .... ***M. wandae***

15. Soralia small; few soredia in each soralium; perforations mostly oval-ellipsoid; apothecia not known; protolichesterinic and lichesterinic acids in medulla .... ***M. tenuis***

Soralia variable; soredia numerous; perforations ± rounded; occasionally fertile; stictic acid complex in medulla .... ***M. magellanica***

16. Upper surface of medullary cavity yellow-orange and UV+ pale orange .... ***M. chrysogaster***

Upper surface of medullary cavity white or brown-black and UV- or UV+ sky blue, with or without orange patches 17

17. Lobes greyish to salad-green on fresh material, emaculate, often with toe-like laterals; soralia scattered, not much confluent; soralia and medulla UV+ sky blue and K+ violet due to hypothamnolic acid .... ***M. violascens***

Lobes greyish, slightly to prominently maculate, without toe-like laterals; soralia and medulla UV–, not K+ violet; stictic acid complex or norstictic acid in medulla 18

18. Soralia small, 0.2-0.6 mm wide, not confluent, occasionally in groups; apothecia rare or common; stictic acid complex in medulla 19

Soralia large, 0.4-1.2 mm wide, often confluent; very rarely fertile; stictic acid complex or norstictic acid in medulla 20

19. Soralia mostly protruding from lobe tips, occasionally laminal; lobes epruinose, glossy, ± flat; apothecia rare; the Neotropics .... ***M. terebrata***

Soralia mostly laminal; lobes slightly pruinose, faintly glossy, often convex; apothecia common; southern South America .... ***M. subpertusa***

20. Lobes only slightly maculate; soralia and medulla occasionally with orange patches due to norstictic acid .... ***M. sanguinascens***

Lobes reticulately maculate; medulla greyish-white, without orange patches; stictic acid complex in medulla .... ***M. kawesqarica***

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MYCOTAXON

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New species and new records of lichenized and non-lichenized pyrenocarpous ascomycetes from the Sundarbans Biosphere Reserve, India

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Abstract — Several species of lichenized and non-lichenized pyrenocarpous ascomycetes are reported from the Sundarbans Biosphere Reserve in India. The species *Astrosphaeriella sundarbanensis* Jagadeesh & Aptroot is new to science. It has the largest ascospores in the genus. Five species are new records for India, viz. *Anisomeridium leptospermum, Anthostomella zongluensis, Julella geminella, Polymeridium proponens* and *Pseudopyrenula subnudata.*

Key word — new species

Introduction

Sundarbans, the largest mangrove reserve of the world, is situated partly in India and partly in Bangladesh, in the delta of the Ganges and Brahmaputra rivers. It comprises a total area of 25,000 sq km. The Indian part covers an area of 9630 sq km and is known as the Sundarbans Biosphere Reserve (SBR). It lies between 21°31' N and 22°41' N latitude and 88°10' E and 89 51' E longitude in the North and South 24-Parganas districts of the state of West Bengal.

Most of the preserved forests of the SBR possesses a rich lichen flora that is unexplored. In the course of floristic studies on the lichens of the area, an intensive collection programme was carried out. Some interesting results have already been published by Jagadeesh & Sinha (2003, 2004) and Jagadeesh *et al.* (2004). In a continuation of these studies, a new species of non-lichenized pyrenocarpous ascomycete is described below as *Astrosphaeriella sundarbanensis* Jagadeesh & Aptroot. Five species are recorded for the first time from India, viz. *Anisomeridium leptospermum* (Zahlbr.) R.C. Harris, *Anthostomella zongluensis* K.D. Hyde, *Julella geminella* (Nyl.) R.C. Harris, *Polymeridium proponens* (Nyl.) R.C. Harris and *Pseudopyrenula subnudata* Mull. Arg. These are briefly described in order to facilitate their identification.

Material and methods

All specimens were hand-sectioned and microscopical observations were made with an Olympus BX50. All measurements are in tap water. The specimens are deposited in ASSAM (Botanical Survey of India, Shillong), BSA (Botanical Survey of India, Allahabad), CAL (Botanical Survey of India, Kolkata), CBS (Centraalbureau voor Schimmelcultures, Utrecht) and ABL (Herbarium Aptroot, Soest) herbaria as mentioned in the text.

Results

Astrosphaeriella sundarbanensis Jagadeesh & Aptroot, **sp. nov.** (Fig. 1)

Astrosphaeriella ascosporis hyalinis uniseptatis 120-145 × 15-20 μm latis.

Type: INDIA, West Bengal, Sundarbans Reserve, Matla island (alt. sea level), on the dry bark of *Sonneratia apetala* Buch.-Ham., T.A.M. Jagadeesh 1036 (BSA – **holotype**; CBS – **isotype**), 28 February 2004.

Ascomata perithecia, solitary, conical, superficial, 0.8-1.3 × 1-1.3 mm; ostiole apical, papillate; peridium dimidiate, base pseudostromatic, black, shining, carbonized, 90-150 (-200) μm thick, KOH+ greenish. Hamathecium colourless, inspersed with abundant oil globules, I-; interthecial hyphae confluent, weakly branched and anastomosed, 1-1.5 μm wide. Asci fusiform, with narrow ocular chamber, 4-spored, biseriate, 185-260 (-300) × 25-37 μm. Ascospores colourless, fusiform, 1-septate, straight to slightly curved, with pointed ends (acuminate), 120-145 × 15-20 μm; locules equal, smooth to granular ornamented or filled with vacuoles.

Remarks: This species grows on dry bark of *Sonneratia apetala* Buch.-Ham. in Sundarbans National Park. It is a typical *Astrosphaeriella* because of the conical ascomata, the fusiform ascospores and the anastomosing paraphysoids. It differs from all c. 40 species currently accepted in the genus (Hyde & Fröhlich 1998; Hyde *et al.* 2000; Wang *et al.* 2004) by the larger ascospores, which are moreover hyaline and only 1-septate, while all other large-spored members of the genus characteristically have pigmented ascospores.

Additional specimens examined: India, West Bengal, Sundarbans Reserve, Haldibari forest camp, 26.2.2004, Jagadeesh 898A (BSA); Maya dwip, 27.2.2004, Jagadeesh 964 (BSA).

Anisomeridium leptospermum (Zahlbr.) R.C. Harris, *More Florida Lichens*: 147. 1995. – *Arthopyrenia adnexa* var. *leptosperma* Zahlbr. *in* Skottsberg, *Nat. Hist. Juan Fernandez* 2: 320. 1924.

Thallus crustose, corticolous, lichenized, whitish to whitish grey, smooth, effuse, evanescent. Ascomata perithecia, mostly solitary, conical to subglobose, superficial, 0.35-0.8 × 0.35-0.6 mm; ostiole apical; peridium complete, laterally spreading. Hamathecium colourless, not inspersed with oil droplets, IKI-negative; paraphyses branched and anastomosed. Asci clavate, 62-91 × 19-22 μm. Ascospores colourless, broadly ovoid, thick walled, transversely 1-septate, slightly constricted at septum, septum submedian, 18-25 × 9-14 μm. Pycnidia conical, 0.1-0.25 × 0.06-0.15 mm; conidia colourless, globose to ovoid, 1.5-2.5 μm diameter. Thallus K-, C-, KC-, PD-, UV-.

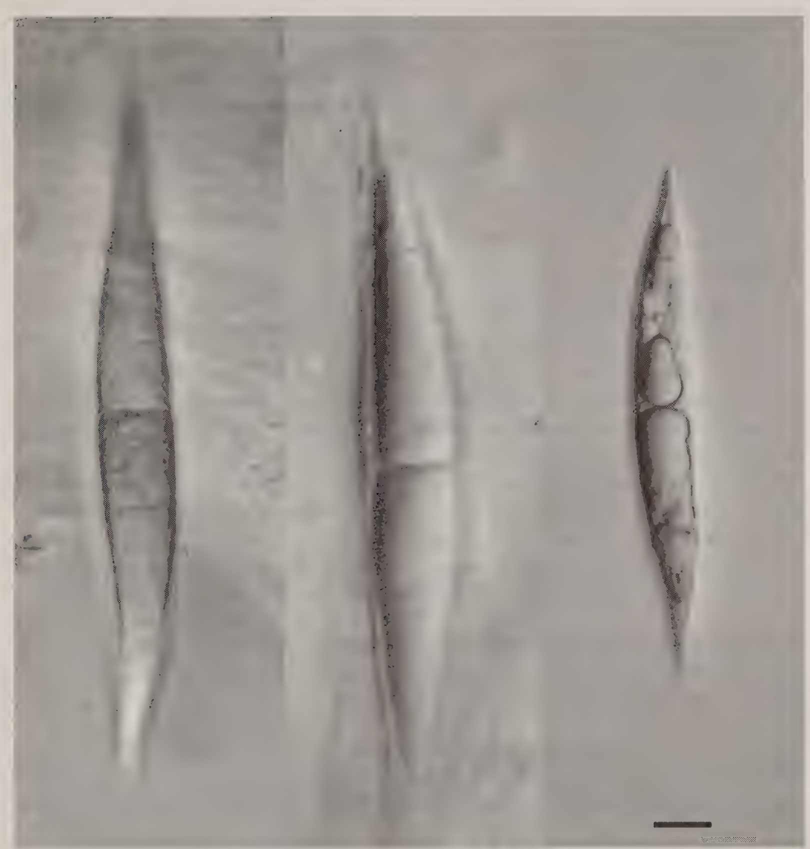

Fig. 1. *Astrosphaeriella sundarbanensis*, ascospores; left and middle ones mature, right one immature, all from the isotype. Bar = 10 μm.

Remarks: This species commonly grows on dry bark of *Sonneratia apetala* Buch.-Ham. and *Xylocarpus mekongensis* Pierre in Sundarbans Tiger Reserve. It is a primarily neotropical species, newly recorded here for India.

Specimens examined: India, West Bengal, Sundarbans Reserve, Katuwajuri, Jagadeesh 760 (BSA); Haldibari forest camp, Jagadeesh 898B (BSA); Maya dwip, Jagadeesh 1004 (BSA, ABL); Goshaba, Jagadeesh 1062 (BSA).

Anthostomella zongluensis K.D. Hyde, *Nova Hedwigia* 62: 333. 1996.

Ascomata perithecia, simple to 2-3 aggregated, subglobose to conical, emergent or partly immersed, 0.4-0.6 × 0.35-0.45 mm; peridium laterally spreading; ostiole apical. Hamathecium colourless, not inspersed with oil droplets, IKI-negative; interthecial hyphae branched and anastomosed. Asci clavate, 54-58 × 9-10 μm. Ascospores reddish brown, ellipsoidal, transversely 1-septate, 10-15 × 4.5-7 μm.

Notes: The specimen was erroneously reported as *Microthelia micula* Korb. by Roychowdhury (1985).

Remarks: This species was so far only known from the type from Hong Kong (Lu & Hyde, 2000).

Specimen examined: India, West Bengal, Sundarbans Reserve, Sajnekhali, on soft wood, November 1975, K.N. Roychowdhury 3927 (CAL, CBS).

Julella geminella (Nyl.) R.C. Harris, *More Florida Lichens*: 87. 1995. – *Verrucaria geminella* Nyl., *Expos. Syn. Pyrenocarp.*: 40. 1858.

Ascomata perithecia, mostly solitary, flattened, 0.35-0.55 × 0.18-0.22 mm; ostiole apical, surrounded by whitish ring; peridium complete, carbonized, laterally spreading. Hamathecium colourless, not inspersed with oil droplets, IKI-negative; pseudoparaphyses simple to branched and anastomosed. Asci clavate to cylindrical, 2-spored, 58-92 × 16-25 μm. Ascospores colourless, ellipsoid-oblong, muriform, transversely 9-15 -septate and vertically 1-4 -septate, 34-58(-65) × 14-19 μm.

Remarks: This species grows on the trunk and twigs of *Avicennia alba* Blume (smooth bark) in Lothian island Wildlife Sanctuary. It is a pantropical species, newly recorded here for India. Characterized by the 2-celled asci.

Specimens examined: India, West Bengal, Sundarbans Reserve, Lothian Island Wildlife Sanctuary, Jagadeesh 12048 (ASSAM), Jagadeesh 1141 (BSA, ABL).

Polymeridium proponens (Nyl.) R.C. Harris, *Bol. Mus. Para. Emílio Goeldi, sér. Bot.* 7(2): 637. 1993 ["1991"]. – *Verrucaria proponens* Nyl., *Bull. Soc. Linn. Normand.*, ser. 2, 2: 130. 1868.

Thallus crustose, corticolous, lichenized, whitish, smooth, ecorticate. Ascomata perithecia, mostly solitary, globular, partly immersed, 0.4-0.7 × 0.4-0.65 mm; ostiole lateral; peridium dimidiate. Hamathecium colourless, not inspersed with oil droplets, I-; paraphysoids weakly or sparsely branched and anastomosed. Asci clavate to cylindrical, 135-205(-220) × 23-28 μm. Ascospores colourless, ellipsoid to ellipsoid-oblong, muriform, transversely 7-11 -septate and vertically 1-4 -septate, 36-55 × 14-21 μm, endospores well developed. Thallus K-, C-, KC-, PD-, UV-.

Remarks: This species commonly grows on the trunk of *Aegioceras corniculatum* (L.) Blanco and *Heritiera fomes* Buch.-Ham in Sundarbans Tiger Reserve. It is a pantropical species, newly recorded here for India. All specimens seen were UV-negative, while the species most commonly reacts UV+ yellow due to the presence of the secondary metabolite lichexanthone.

Specimens examined: India, West Bengal, Sundarbans Reserve, Chamta, Jagadeesh 13571 (ASSAM, ABL), Jagadeesh 13582 (ASSAM); Matla, Jagadeesh 1041 (BSA).

Pseudopyrenula subnudata Mull. Arg., *Flora* 66: 249. 1883.

Thallus crustose, corticolous, whitish, smooth. Ascomata mostly solitary, superficial, subglobose, 0.32-0.6 × 0.2-0.35 mm; ostiole apical; peridium complete, laterally spreading. Hamathecium yellowish, gelatinized, inspersed, KOH+ reddish, I-negative; paraphysoids branched and anastomosed. Asci clavate, 65-85 × 11-16 μm. Ascospores colourless, oblong to fusiform-oblong, transversely 3-septate, 16-22 × 4.5-6 μm. Pycnidia of two types: pycnidia of macroconidia globose to subglobose, 0.07-0.09 × 0.06-0.9 mm; macroconidia colourless, ellipsoid, 7-9 × 4-5.5 μm; pycnidia of microconidia conical, 0.1-0.15 × 0.08-0.13 mm; microconidia colourless, filiform, straight, 5-6.5 × 0.7-1 μm. Thallus K-, C-, KC-, P-, UV-.

Remarks: This species commonly grows on the trunk and twigs of *Ceriops decandra* (Gritt) Ding Hou and *Excoecaria agallocha* L. in Sundarbans Tiger Reserve. It is a pantropical species, newly recorded here for India.

Specimens examined: India, West Bengal, Sundarbans Reserve, Chamta, Jagadeesh 13543 (ASSAM); Raimangal, Jagadeesh 698 (BSA); Katuwajuri, Jagadeesh 749 (BSA, ABL); Haldibari, Jagadeesh 922 (BSA).

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Hydnochaete paucisetigera, a new species of *Hymenochaetales*

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Abstract—A new species *Hydnochaete paucisetigera* is described from Taiwan; it is one of the only two non-polyporoid species of *Hymenochaetales* s. str. with extremely rare abortive setae.

Key words—setae, *Hymenochaete paucisetosa*, Taiwan

Methods

Basidiomata of the new species are described using the colour notations given in the Munsell Book of Color (1976; abbreviation: M) and Methuen Book of Colour by Kornerup & Wanscher (1967; abbreviation: K & W). Microscopic study was carried on on making free-hand sections or as squash mounts in 2% aqueous solution of KOH. Mean size for the basidiospores is based upon the measurement of 25 spores. Herbarium acronyms are after Holmgren, Holmgren & Barnett (1990).

Taxonomic Description

Hydnochaete paucisetigera Parmasto & Sheng H. Wu, **sp. nova** Fig. 1

Basidiomata effuso-reflexa, dura, ad 3 mm crassa; pileus angustus vel ad 6 mm latus, superficie tomentoso-sulcata. Tomentum, cortex et stratum hypharum adsunt. Systema hypharum subdimiticum; hyphae skeletoideae crasse tunicatae, brunneae, 3-5 μm in diam; setae rarissimae, 25–40 x 4–6(–8) μm; hyphidia numerosa, tenuiter tunicata, 12–15 x 2.5–3 μm; sporae anguste cylindricae, arcuatae, 4.2–5.5(–5.7) x 1.4–1.8(–2) μm.

Holotype: Taiwan, Nantou, Huisun Forestry Station, alt. 770 m, on a fallen branch, 12 Dec 1997, S.H. Wu et al., *Wu 9712-12* (TNM F10074; isotype: TAA).

Etymology: *pauca,* few; *setigera,* carrying setae.

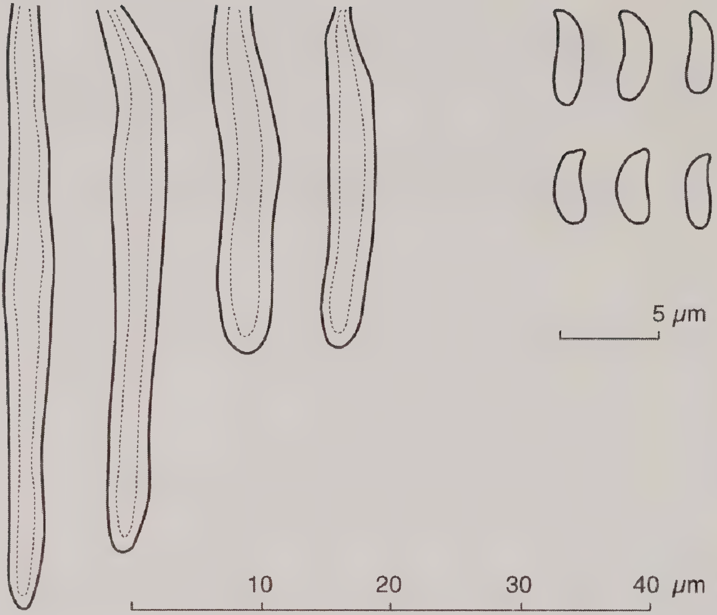

Fig. 1. Spores and setae of *Hydnochaete paucisetigera*

Basidiomata resupinate with slightly elevated narrowly pileate margins or effuse-reflexed, woody hard with brittle teeth, up to 3 mm thick, 1–2 cm in diam, then confluent and up to 7 cm long; pilei 1–6 mm long and up to 10 mm broad, upper surface dark umber, velutinate, concentrically sulcate; hymenophore as densely (2.5–4 per mm) situated round or slightly flattened blunt-edged teeth 0.5–2.5 mm long and 0.2–0.4 mm diam, not cracked, yellowish brown, dark fulvous or almost umber (M: 5 YR 5–7/6; K & W: 6 C 4, later 6 D–E 5 – 5 D 5). Tomentum well developed, 50–100 μm thick; cortex present, distinctly seen in sections, 30–50 μm thick; hyphal layer 50–150 μm thick, composed of densely radiately arranged hyphae; hyphae of the teeth dense and parallel, lacking a dark line adjacent to the hymenium; setal layer absent (hymenium not thickening).

Hyphal system subdimitic; setal hyphae absent; generative hyphae 3–4.5 μm in diam, yellowish, with thickened walls; skeletoids numerous, thick-walled, brownish, 3–5 μm in diam. Setae restricted to the hymenium, extremely rare, brownish, with thickened walls, with a blunt tip, 25–40 x 4–6(–8) μm. Hyphidia 12–15 x 1.5–3 μm, subhyaline, very numerous, some encrusted with small resinous granules; basidia clavate, 20–25 x 3.5–4.5 μm, with 4 thin sterigmata 2–3 μm long; spores narrowly cylindrical, curved, 4.2–5.5(–5.7) x 1.4–1.8(–2) μm.

Other specimens examined: Taiwan, Nantou, Tungpu, alt. 1500 m, on branch of an angiospermic tree, 22 Aug 1992 S.H. Wu, *Wu 9208-45* (TNM F00837, TAA), *Wu 9208-24* (TNM F00833, TAA).

Remarks. Only the type specimen of this species has abundant spores. Their mean size is 4.74 x 1.60 µm, with a mean length/width quotient $Q = 2.96$.

H. paucisetigera is somewhat similar to *H. tabacinoides* (Yasudai) Imazeki which differs in presence of numerous hymenial setae 40–90(–120) x 8–16(–20) µm and semilamellate teeth.

Most poroid (polyporoid) genera of *Hymenochaetales* s. str. are characterized with presence of setae, some genera with their absence (*Aurificaria* D.A. Reid, *Coltriciella* Murrill, *Fulvifomes* Murrill, *Inocutis* Fiasson & Niemelä, *Inonotopsis* Parmasto, *Phylloporia* Murrill). In only two poroid genera, *Coltricia* Gray and *Fomitiporia* Murrill there are species both with and without setae. In the non-poroid *Hymenochaetales* (*Asterodon* Pat., *Clavariachaete* Corner, *Dichochaete* Parmasto, *Hydnochaete* Bres. s.l., *Hymenochaete* Lév. s.l. including *Cyclomyces* Fr.) all species have setae. In *Hd. paucisetigera,* so also in *Hymenochaete paucisetosa* Léger & Lanquetin, the setae are very rare and abnormally developed. *H. paucisetosa,* found in Gabon (West-Central Tropical Africa) differs in having subellipsoidal spores 2.8–3.2 x 1.5–2 µm and flabelliform sessile basidiomata.

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Hymenochaete ulmicola sp. nov. (*Hymenochaetales*)

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Abstract—*Hymenochaete ulmicola* is described. The basidiomata grow between bark scales of old living *Ulmus* trees in Europe (Czechia, Denmark, Estonia, Finland, Norway, Russia, Sweden).

Key words—*Hymenochaete carpatica, H. rubiginosa,* corticolous fungi

Methods

Basidiomata of the new species are described using the colour notations given in the Munsell Book of Color (1976; abbreviation: M) and Methuen Book of Colour by Kornerup & Wanscher (1967; abbreviation: K & W). Microscopic study was carried on making free-hand sections or as squash mounts in 2% aqueous solution of KOH. Mean size for the basidiospores is based upon the measurement of 25 spores. Herbarium acronyms are after Holmgren, Holmgren & Barnett (1990). In the list of localities, E.P. = E. Parmasto, P.C. = P. Corfixen.

Taxonomic Description

Hymenochaete ulmicola Corfixen & Parmasto, **sp. nova** Figs. 1-3
Syn.: *H. rubiginosa* f. *minuta* Pilát, Hedwigia 70 (1/2): 119 (1930).

Basidiomata perennia, lignea, umbonata, effuso-reflexa vel cupulata. Tomentum, cortex, stratum hypharum atque stratum setosum adsunt. Systema hypharum subdimiticum; setae numerosae, (50–)60–90 x (6–)7–9(–11) μm, subulatae, acutae. Basidia 18–25 x 4.5–6 μm, 4-sterigmatibus; sporae ellipsoideae, uno latere depressae, 5.5–7.5 x 3–4 μm.

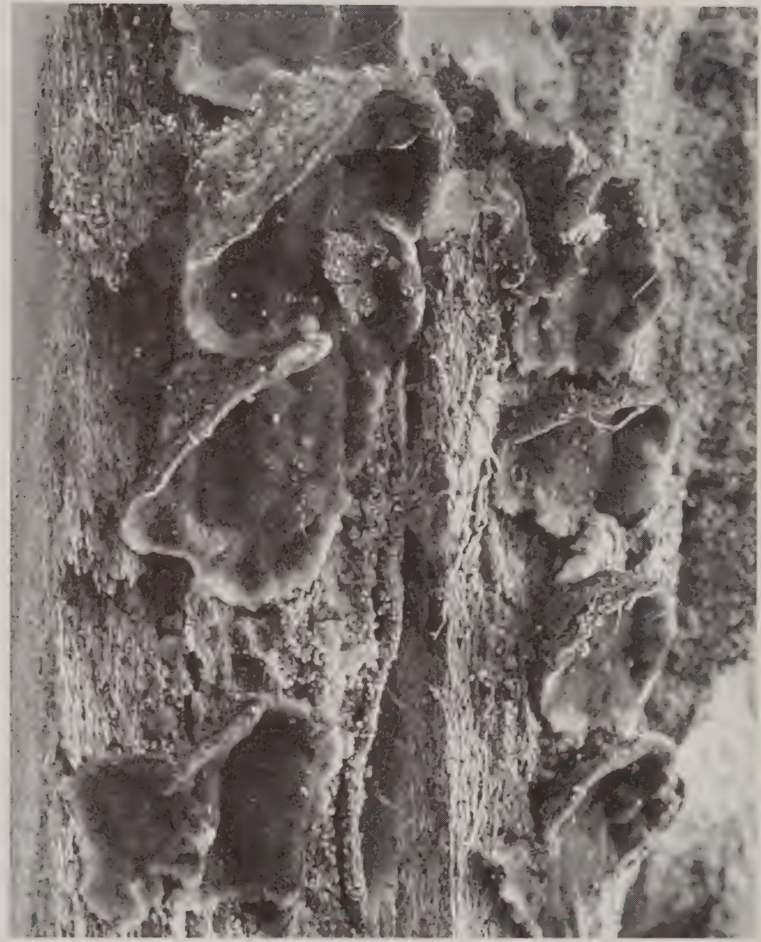

Fig. 1. Basidiomata of *Hymenochaete ulmicola*

Holotype: Denmark, Sjælland, Frederiksværk Comm., Glædelundgård, on *Ulmus glabra,* 29 Jul 1991 P. Corfixen (C, no PC 4044).
Etymology: *ulmicola*, growing on *Ulmus*.

Basidiomata perennial, effuso-reflexed with slightly elevated margins, or with well developed umbonate-adnate pilei, almost cupulate, usually fixed to the substratum with an umbonate point, woody hard, brittle when dry; resupinate part up to 1 cm in diam, pilei 2–5 mm long, 3–10 mm in width, 200–700(–1000) μm thick, single or a few confluent. Pileal surface concentrally sulcate with few furrows in the marginal part, when young concentrically roughly hairy, later glabrous, dark brown or blackish

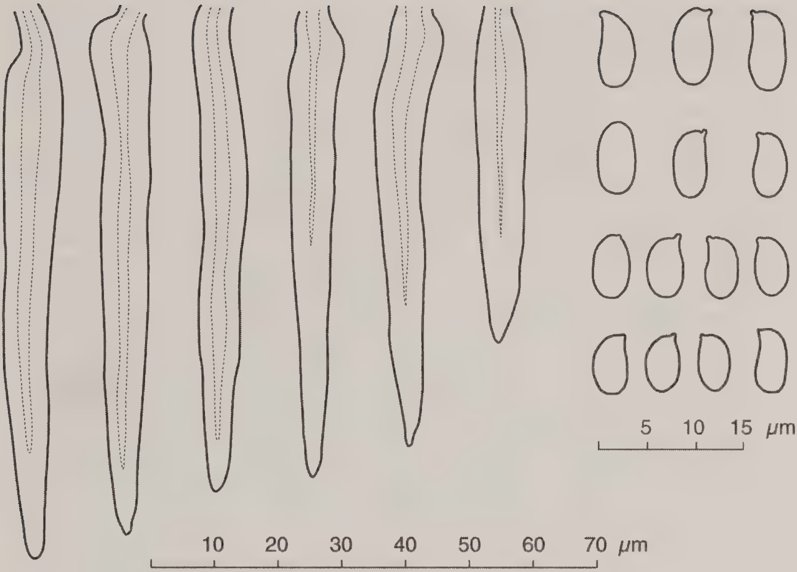

Fig. 2. Setae and spores of *Hymenochaete ulmicola*

(M: 5 YR 4/4; K & W: 6 E 4, when old 5 YR 3/4; 6 F 5–4 or 6 F 9, blackish chocolate brown); margin thin, slightly lobate. Hymenium smooth or with scattered tubercles, not cracked, light brown (M: 5 YR 4/6 to 4/8; K & W: 6 D 4–5 or 5 E 6, camel to sunburn or mustard brown).

Tomentum present as tomentose zones on pilei, 50–80 μm thick, later vanishing; cortex present, 30–60(–75) μm thick; hyphal layer well developed, up to 200 μm thick, composed of almost densely radially interwoven hyphae; setal layer thickening, with up to 5 indistinct or distinct strata (layers), up to 400(–800) μm thick.

Hyphal system subdimitic; hyphae with thickened walls, 2.5–3.5(–4) μm in diam, skeletoids brown, generative hyphae subhyaline; hyphae in the thickening hymenium vertically arranged, with numerous septa, 4–5 μm in diam. Setal hyphae absent but some bending downwards setae with horizontal elongated base up to 100 μm long. Setae numerous, confined to the hymenium, (50–)60–90 x (6–)7–9(–11) μm, subulate, with acute tip, naked or enmeshed in hyphal sheaths, without incrustation, projecting up to 50 μm. Cystidia and hyphidia absent but basidioles numerous, hymenium encrusted with granules of resinous matter; basidia 18–25 x 4.5–6 μm, subcylindrical, with 4 sterigmata, each about 3 μm long; spores ellipsoid, with one side flattened, 5.5–7.5 x 3–4 μm.

Ecology. Basidiomata are growing on lateral sides of bark scales (in bark fissures) of old living *Ulmus* trees (mainly of *U. glabra).*

Other collections studied: Denmark, Sjælland: Frederiksværk Comm., Glædelundgård, 31 Jul 1991 P.C. (C no. PC 4045, 4046); Farum, Sortemose, 24 Sept 1993 P.C. (C); Tølløse, Åstrup, 15 Jan 1996 U. Søchting (C); Bornholm: Gudhjem; 14 Sept 1993 P.C. (C). Estonia: Viljandi Co, Viiratsi Comm., Tusti, in a park, on bark of *U. glabra,* 4 Oct 2003 E.P. (TAA 184826); Viljandi City park, on bark of *Ulmus glabra,* 15 Oct 2003 E. & I. Parmasto (TAA 184847, 184848); Saarepeedi Comm., Võistre, on bark of *U. glabra,* 17 Oct 2003 E.P. (TAA 184850); Jõgeva Co, Alam-Pedja Nature Reserve, Altnurga nemoral *Ulmus-Fraxinus* forest, on bark of *U. glabra,* Nov 2003 E. Tammur & I. Parmasto (TAA 184861, 184887). Finland: Uusimaa Prov., Lohja Comm., Torhola, 4 Oct 1978 P. Uotila (H 27910). Norway: Møre og Romsdal Prov., Nesset Munic., Eikesdal under Ragnåtind, on bark of *Ulmus glabra,* 16 Sep 2003 J.B. Jordal (TAA 184860). Russia: Bashkortostan, Sterlitamak, Mebelnyi, mountain N of village, on *Ulmus scabra,* 30 Aug 2002 P.C. (C no PC 02.147); Bashkortostan, Tazlarovo, Bolshaya Suren River, 5 km SE of town, on *Ulmus scabra,* 3 Sep 2002 P.C. (C no PC 02.184); Chelyabinsk Reg., Vilyay 20 km S of Ascha, on *Ulmus scabra,* 29 Aug 2002 P.C. (C no P.C. 02.146); Orenburg Reg., Saraktash, Kayrovka, Belgushka River by the mountain, on *Ulmus scabra,* 2 Sep 2002 P.C. (C no PC 02.163). Sweden: Halland, Sibbarp Parish, Sibbarp church, 15 Dec 1974 T. Hallingbäck (GB); Skåne, Brunnby Parish, Kulleberg, Arild by Haga, 12 Jul 1943 G. Degelius (GB); Skåne, Brunnby, Hagagården by Arild, 12 Jul 1943 (LD); Uppland, Bondkyrka Parish, Vårdsätra gård, 7 Feb 1937 G. Degelius (GB); Västergötland, Askim Parish, Billdalspark, 24 Nov 1974 J. Eriksson (GB); Skövde Comm., near Flämslätt, 7 Sep 2003 E.P. (TAA 184805); Södermanland, W of Nyköping, 11 Jul 1992 J. Heilman-Clausen 92-161 (C). Czechia: Brodek near Olomouc, on *Ulmus,* Apr 1912 R. Picbauer (PR 686972, holotype of *H. rubiginosa* f. *minuta* Pilát; isotypes in BRNM, HBG).

Remarks. Basidiomata of the new species are hardly remarkable; the habitat is similar to the possibly closely related species *H. carpatica* Pilát which differs in always being resupinate (effused), firmly attached to the substrate, basidiomata growing in Europe mainly on *Acer pseudoplatanus,* absence of tomentum, absence or indistinct cortex and hyphal layers, large setae 50–140 x 6–9 μm and in general slightly smaller spores (5.0–)5.5–6.5(–7) x (2.8–)3–3.5(–3.8) μm (Tomšovský, 2001); mean size: 5.8–6.3 x 3.1–3.6 μm. The basidiomata of *H. ulmicola* look like the ones of *H. rubiginosa* in miniature; the latter has the same type of structure (tomentum, cortex, hyphal and setal layers present) but differs by small spores 3.5–5.5 x 2–3 μm.

Mean spore size and Q value in *H. ulmicola:*

5.79 x 3.14 μm	1.84	(Norway, TAA 184860)
6.06 x 3.27 μm	1.85	(Estonia, TAA 184861)
6.18 x 3.52 μm	1.76	(Estonia, TAA 184887)
6.20 x 3.39 μm	1.83	(Estonia, TAA 184850)
6.36 x 3.33 μm	1.91	(Russia, Chelyabinsk, C no PC 61560)
6.60 x 3.40 μm	1.94	(Estonia, TAA 184848)
6.75 x 3.41 μm	1.98	(Russia, Orenburg, C no PC 61577)
6.82 x 3.44 μm	1.98	(Estonia, TAA 184826)
6.89 x 3.59 μm	1.92	(Sweden, TAA 184805)

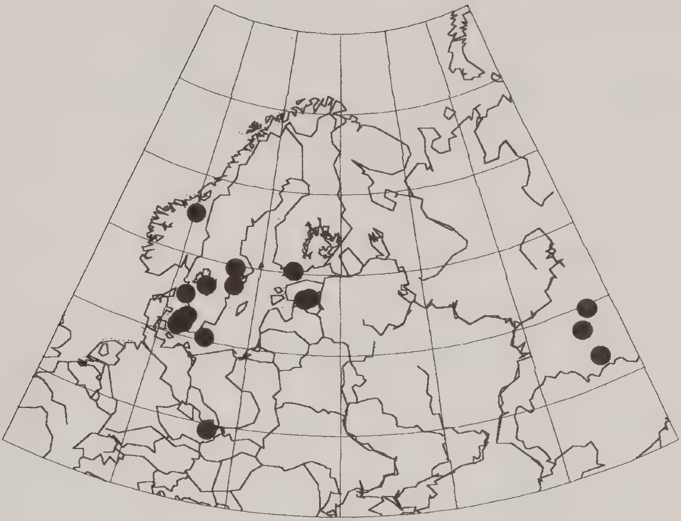

Fig. 3. Localities of *Hymenochaete ulmicola*

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MYCOTAXON

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New records of *Hygrocybe* from the Gulf of Mexico area

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Abstract— Two members of the genus *Hygrocybe* (sect. *Coccineae*) with green basidiomes were recorded in the central area of Veracruz State, viz. *H. chloochlora* and *H. virescens*. The collections were compared with the respective holotypes from Martinique and U.S.A. Additional macro and microscopical variation based on the recent collections from Mexico is presented for each species. Descriptions and discussions, including illustrations of macro and microscopic features, are provided.

Keywords— *Hygrophoraceae*, type study, taxonomy, subtropical fungi

Introduction

As part of a monitoring program of macromycetes in the central area of Veracruz State, we detected three populations belonging to two species of *Hygrocybe* with green basidiomes, which were not previously documented in the area. One of these populations was found at the edge of a cloud (subtropical) forest, adjacent to the Instituto de Ecología (Xalapa). The other two populations were found, growing among grass in both the Botanical Garden of the Instituto de Ecología and the Universidad Veracruzana Campus. The three sites are around 1300 m.a.s.l. Collections of the population growing in the forest were found conspecific with the type specimen of *Hygrocybe chloochlora* Pegler & Fiard from Martinique, and those from the Botanical Garden and the University Campus, with *H. virescens* Hesler & A.H. Sm. from the U.S.A. Present records from Mexico represent evidence of a wider geographic distribution for these American species. *Hygrocybe chloochlora* has been reported from the Caribbean (Pegler and Fiard 1978; Lodge and Pegler 1990), whilst *H. virescens* is known, apparently, only on the basis of its description from California, U.S.A. (Hesler and Smith 1963; Largent 1985; Arora 1986).

Materials and Methods

Macroscopic descriptions are based on the study of fresh material. Color codes indicated in the descriptions are based on Kornerup & Wanscher (1967) and Kornerup & Wanscher (1978) (in this case indicated by underlined alphanumeric codes). Microscopic structures are described from hand sections of revived tissues mounted in 3% KOH and Congo

Red 1% aqueous solution. Measurements and colors of the structures were observed in 3% KOH. The basidiospores were measured in side view, 30 spores of a single element per collection were evaluated selected at random from hymenophoral tissues. When estimating spore dimensions part of the recommendations by Heinemann and Rameloo (1985) were used. The first range reported in the descriptions is to describe the variability within the collections. Extreme values are indicated in brackets (highest values of mean ±2 SD in each sample). The means of spore length, width and quotient Q (ratio of basidiospore length/basidiospore width) were calculated in a single element of each collection, then **RM** corresponds to the range of means of length and width of **n** collections. **Q** refers to the range of the mean values of Q of **n** collections. Line drawings were made with the aid of a drawing tube. Herbarium acronyms are according to Holmgren et al. (1990).

Taxonomy

Hygrocybe chloochlora Pegler & Fiard, Kew Bull. 32: 303, 1978. **Figures 1-3**

Pileus 8–30 mm wide, convex to plano-convex, often depressed in the center, at times finally uplifted, occasionally irregularly perforate, then around the hole the pileipellis appears ripped, faintly translucent striate from the margin towards half of pileus ratio, finely radially innately fibrillose (under lens), hygrophanous, moist, green, pistachio to pale green, apple green (1B4-3, 28A3-6, 29A3-4, 30B4-5), more intensely coloured (29A4-5, 29B4-5, 28B4-6, 28C6, 27A3-5, 27B5) or even very dark green (27E5-8, 27F7-5, 27F2, 28D6-E7-F3) with a contrastingly lighter, cream or pale yellowish-green (30A2-3) or even whitish margin, sometimes faded cream-yellow (2A4-3) or whitish at center, occasionally with orange-brown spots (5B7-6, 5C7-6); margin translucent striate, paler than pileus surface (30A3-2), frequently ripped, irregular, edge thin, at times somewhat expanded as a pendant, translucent membrane, then somewhat appendiculate, decurved. ***Lamellae*** adnate to somewhat decurrent, straight or more or less arcuate, at times subventricose to ventricose, broad (1.5–4 mm wide), subdistant to distant, thick, waxy, pale green (1B4, 30A4-2) or dark green (28A3-6, 28B4, 28B6, 29A2-5, 27A3-4), even very dark green upwards (27A4-5, 27E4-7, 27D7, 30F5), whitish towards the edge, at times all the surface cream yellow with greenish tinges or with pale orange-ochre stains; margin irregular, serrulate, paler or yellowish-green to yellowish; lamellulae of two or three different sizes. ***Stipe*** 23–58 × 3–6 mm, cylindrical, other flattened, at times curved at base, fistulous towards the superior half to entirely fistulous with age, dry but with waxy appearance, glabrous, at times superficially covered above with white, very fine, scattered fibrils or in others as very fine furfuraceous patches, somewhat striate towards the apex, green (1B4-3, 27A2-5, 27B4-5, 27E7-D7, 28A3-5, 28E5-6, 30A2-3, 30B4-5) to somewhat bluish-green (26D6, 27D5-6), frequently paler downwards (2B4-5, 28A5), staining pale ochre; base whitish, yellow to yellowish (2B4-5, 2A3-2, 3A3). ***Context*** hygrophanous, whitish in the middle area of stipe and pileus, and around the fistula, remaining areas green (29A4) or concolorous to stipe surface. ***Odor*** and ***taste*** mild.

Basidiospores dimorphic: ***macrospores*** (11–) 12.8–20 × (6.4–) 7.2–10 (–11.4) μm, **RM** = 15–17 × 8–9 μm, **Q** = 1.91–2.0, **n** = 8 colls., elongate to ellipsoid, frequently faintly

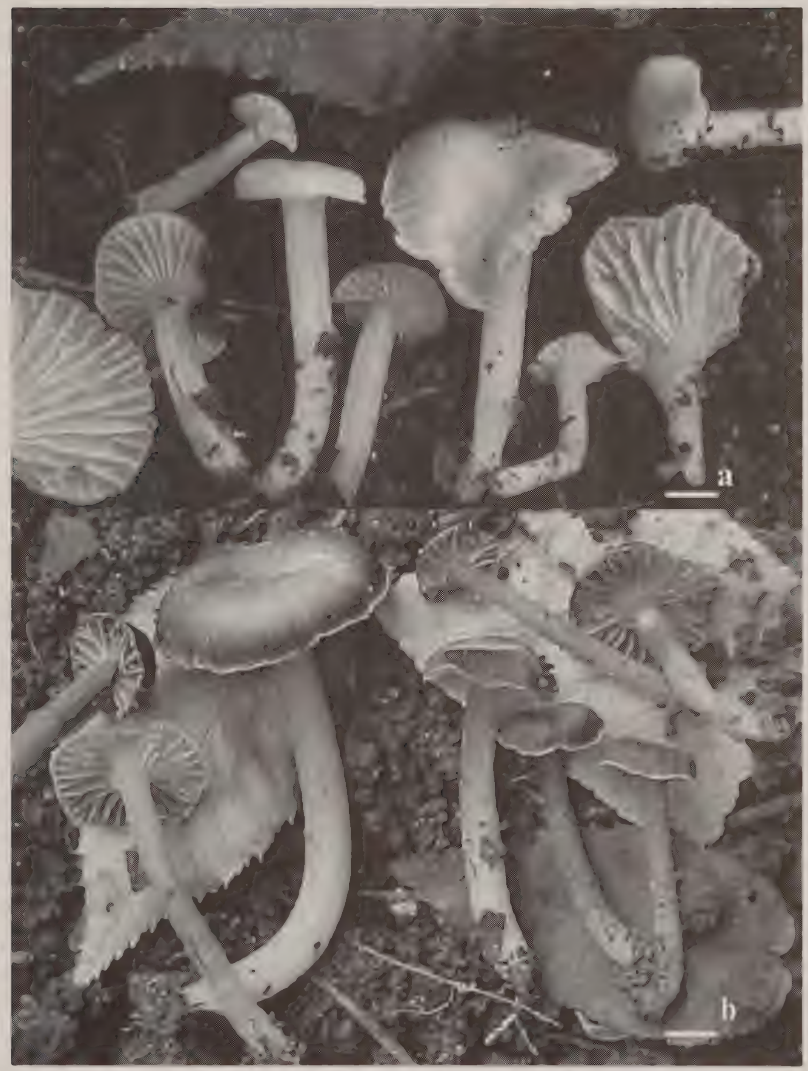

Fig. 1. ***Hygrocybe chloochlora*** basidiomes (a: *Montoya 4054*; b: *Montoya 4057*). Bar = 10 mm.

constricted in the middle portion or slightly attenuated towards the apex; ***microspores*** (4.2–) 4.8–6.4 (–7.2) × 3–4 (–4.8) µm, **RM** = 5.4–6 × 3–4 µm, **Q** = 1.58–1.61, **n** = 8 colls., more or less similar in shape to macrospores; both thin-walled, hyaline and inamyloid, with refringent granular contents. ***Basidia*** dimorphic: ***macrobasidia*** 57–

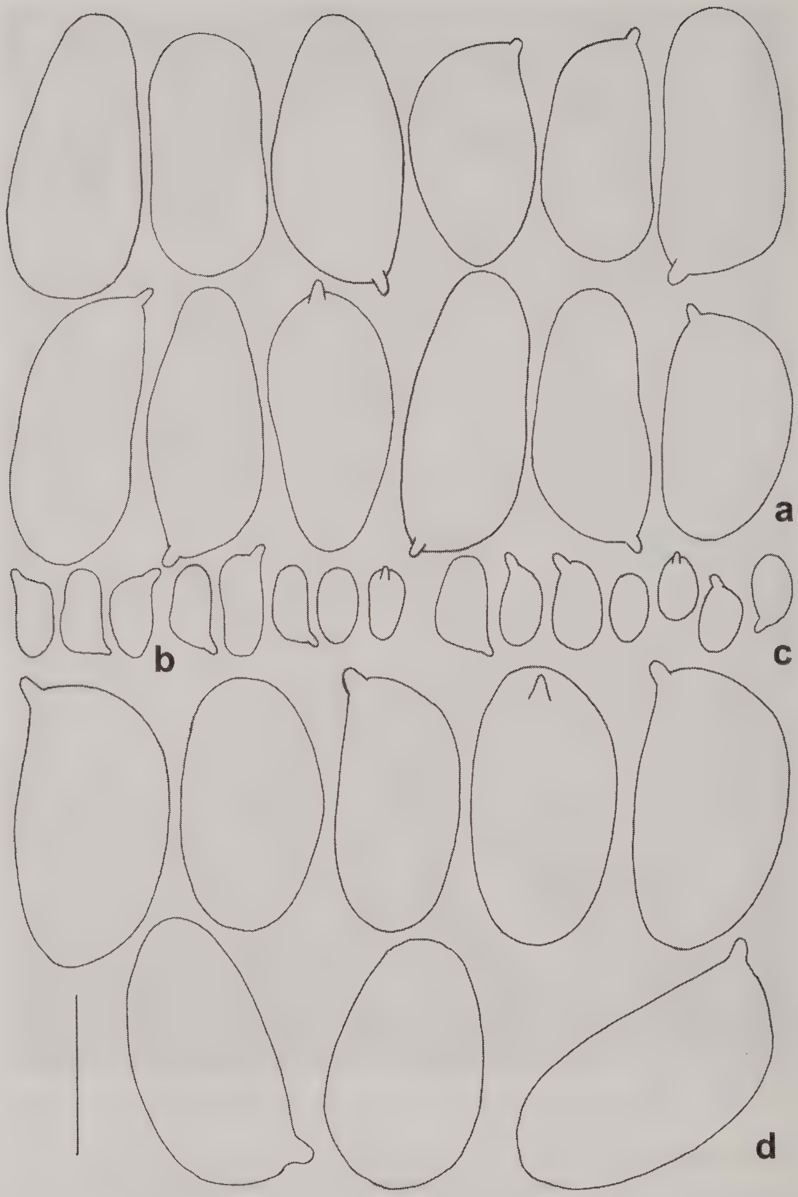

Fig. 2. ***Hygrocybe chloochlora***. a, d: macrospores; b-c: microspores (a-b: *Montoya 3954*, c-d: *J.P.Fiard 168* (*Holotype*). Bar =10 μm.

60 × 14.4–16.2 µm, tetrasporic, broadly clavate to more or less sphaeropedunculate, with needle or granular contents; ***microbasidia*** 26.4–37.8 × 4.8–6.6 µm, tetrasporic, at times monosporic, clavate to subcylindric; both hyaline, thin walled, clamped. ***Cystidia*** absent; lamellae edge composed of clavate, subcylindric, decurved elements, 17.4–49 × 3.6–5.6 µm, some septate, clamped, hyaline. ***Pileipellis*** a cutis, hyphae periclinally oriented, 6–12 µm wide, hyaline, not gelatinized. ***Pileus trama*** hyphae 4.2–18 µm, clamped, incrustate and refringent hyphae often present, some elements 3–4.2 µm wide with dense contents. ***Hymenophoral trama*** regular to subregular, hyphae 3–19.8 µm, cylindrical, clamped, other incrustate, with elements with dense contents 2.4–4.2 µm wide, some ramified; subhymenial elements ramified, short-septate, 3–3.6 µm diam, clamped. ***Clamp connections*** numerous.

Habitat. Gregarious in small troops, on soil, among dead leaves or grass, near *Carpinus caroliniana* L. Walter, in the edge of a narrow road which crosses a cloud forest.

SPECIMENS EXAMINED — MEXICO. VERACRUZ: Mpio. Xalapa, Instituto de Ecología, Santuario del Bosque de Niebla, 1300 m.a.s.l., 21.X.2002, *Bandala 3713*; 1.X.2003, *Bandala 3829*; 25.X.2002, *Montoya 3954*; 26.XI.2003, *Montoya 4054, 4055*; 29.XI.2003, *Montoya 4056*, *4057*; 9.VII.2004, *Bandala 3925*; 7.VII.2004 *Jarvio* 1703; 13.*VII.2004, Bandala 3930*; 11.VIII.2004, *Montoya 4161*; *Jarvio 1779*; 18.VIII.2004 *Jarvio 1791* (all at XAL).

Other material studied — MARTINIQUE. ABSALON, 700 m.a.s.l., November 1974, *J.P.Fiard 168* (*Holotype*, KEW).

Remarks. The Mexican specimens studied correspond to a single population that we mapped and visited periodically through January 2002-August 2004. These specimens led us to observe additional macro and microscopical variation to that recorded by Pegler and Fiard (1978) and Lodge and Pegler (1990) in their Caribbean collections of *Hygrocybe chloochlora* [sect. *Coccineae* Fayod (Singer 1986)]. It should be noted that the basidiomes of Mexican samples reached a wider color range, which embraces the range reported for the species: in a gradient from very pale green to very dark green, even blackish-green, including the lamellae. If darker basidiomes had been collected in a different area, they could probably have given the appearance of a different variant. The stipe and lamellae stain ochraceous and the stipe lacks the red to rufous flushes at times present as observed by Lodge and Pegler (1990). Some differences are found between Mexican and Caribbean collections regarding the macrospore shape, those of the latter being slightly more broadly ellipsoid with Q = 1.78 (Pegler and Fiard 1978), 1.74 (Lodge and Pegler 1990) or 1.73 as observed in the holotype. The type specimen presented ellipsoid macrospores without constrictions. Pegler and Fiard (1978) described them as ellipsoid to subcylindric, and although Lodge and Pegler (1990) did not describe basidiospores, they draw (p. 447) a somewhat reniform one. Taking into account the wide colour variation shown by other species of *Hygrocybe*, we are not completely convinced that this feature is important enough as a major difference to recognize Mexican specimens as a separate taxon. Further collections of *H. chloochlora* in the type locality could reveal if the constricted basidiospores are also part of its variation, or if such pattern found in the collections either from Mexico or Puerto Rico, correlated with macroscopic features above mentioned is indicative of the existence of a sister taxon, probably representing a variety.

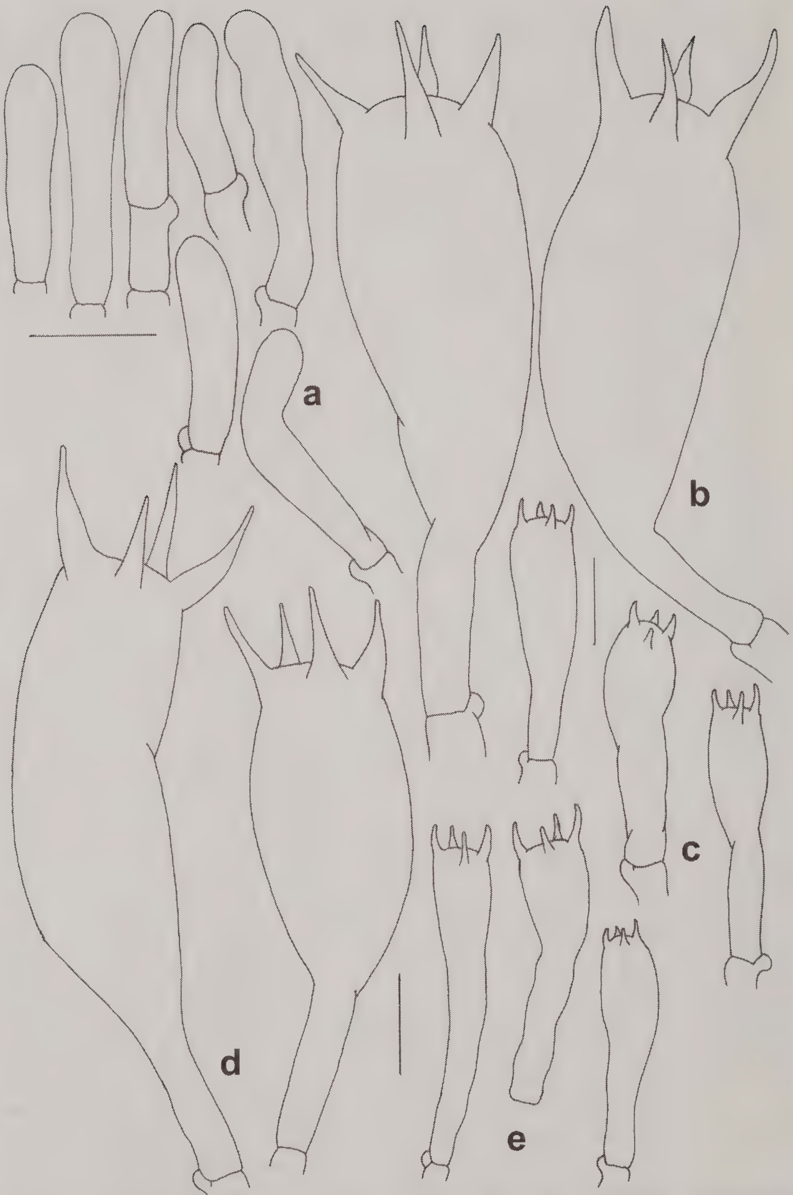

Fig. 3. ***Hygrocybe chloochlora***. a: hymenial marginal elements; b: macrobasidia; c: microbasidia (*Montoya 3954*); d: macrobasidia; e: microbasidia (*J.P.Fiard 168, Holotype*). Bar = 10 μm.

Hygrocybe virescens Hesler & A.H. Sm., N. Am. Sp. of *Hygrophorus*, p. 192, 1963. **Figures 4-5**

Pileus 17–40 mm wide, convex to broadly campanulate, becoming somewhat expanded and then convex and broadly obtuse, occasionally subumbonate, umbilicate, striate from nearly the central area of the disc towards the margin, splitting longitudinally to the margin, wavy with age, silky fibrillose, fibrils attached but at times loose at the disc, green (1E8, 28BC5-6, 28D6, 28E7-8, 29BC6 29DE8-F5 29F7-8 30F8), darker with age, somewhat brownish olive faded yellowish-green (4C5), yellowish (2A3-4) to yellow (3-2B7) or yellow–brown (3C-D8) at the very center; margin somewhat decurved to plane, later irregularly wavy, at times turned up. ***Lamellae*** adnate by a tooth but tending to detach, ventricose (3–7 mm wide), subclose to distant, easily breaking, green (1B4-5, 1D5) at the boundaries of pileus context, paler or even whitish towards the margin, finely rugose to venose at the surfaces; margin irregular to serrulate; lamelullae of one to two different sizes. ***Stipe*** 30–80 × 5–8 mm, cylindrical, at times fasciculate, fistulose, smooth, but innately fibrillose (under lens), at times with scattered fine tomentum at the apex, green (1C8-D8) to yellowish-green (1AB6, 1B3-4, 1C6-7) or yellowish (2A6-B6), darker with the time; base paler or white, with white mycelium. ***Context*** whitish to yellowish, greenish to yellowish-green (2B7-C7) towards the pileipellis, yellow in the center. ***Odor*** none; ***taste*** mild.

Basidiospores (7.2–) 8–9.6 (–10.4) × (4.8–) 5.6–6.4 µm, **RM** = 8.5–9 × 5.4–6 µm, **Q** = 1.5–1.6, **n** = 5 colls., ellipsoid to subcylindric, smooth, thin-walled, hyaline, at times with dense, fragmented contents, inamyloid, hilar appendix more or less prominent. ***Basidia*** (34–) 40–54.4 × (8–) 8.8–11.2 (–12) µm, clavate, tetrasporic, at times monosporic, thin-walled, hyaline, some with refringent fragmented contents, clamped. ***Cystidia*** absent; marginal elements of lamellae 18.4–28 × (4.8–) 6.4–8.8 µm, cylindric, clavate, thin-walled, hyaline, clamped. ***Pileipellis*** a cutis, rarely with projected elements, not gelatinized or only slightly gelatinized, hyphae of 3–10.4 µm wide, periclinally oriented, hyaline to pale yellowish in mass, at times some elements with dense contents, clamped. ***Pileus trama*** with thin-walled, cylindric, hyphae (4.8–) 8–17.4 µm wide, some inflated, hyaline, yellowish in mass, clamped, some elements with dense contents. ***Hymenophoral trama*** regular, hyphae (4.2–) 5.6–12 µm wide, slightly gelatinized, hyaline, some elements 3–4.8 µm wide, with dense contents, ramified, flexuous, thin-walled; subhymenial hyphae 2.4–3.2 µm wide, short, often bifurcate, hyaline, clamped. ***Clamp connections*** numerous.

Habitat. Gregarious, on soil, among grass, in gardens, near *Cupressus*.

SPECIMENS EXAMINED — MEXICO. VERACRUZ: Mpio. Xalapa, Instituto de Ecología, Botanical Garden Francisco J. Clavijero, 1300 m.a.s.l., 3.VII.2002, *Montoya 3829*; 1.VIII.2002, *Montoya 3871*; 4.IX.2002, *Montoya 3909*; 6.VIII.2002, *Bandala 3653*. Campus UV, USBI, 22.VI. 2003, *Montoya 3993* (all at XAL).

Other material studied — U.S.A. CALIFORNIA: Trinidad, 14.XII.1956, *A.H. Smith 56649* (*Holotype*, MICH).

Remarks. *Hygrocybe virescens* (sect. *Coccineae*) has been collected and studied in detail only by Hesler and Smith (1963) from California and later redescribed by Largent (1985).

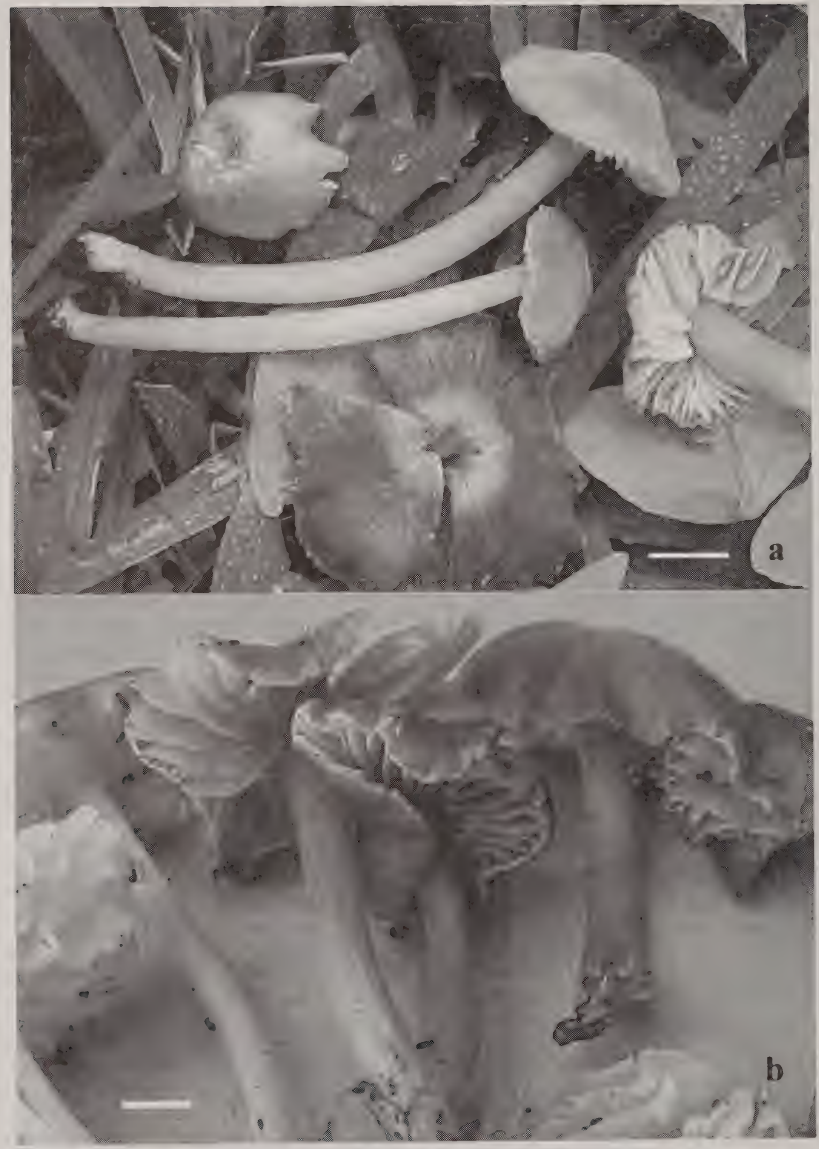

Fig. 4. ***Hygrocybe virescens***. Basidiomes (a: *Montoya 3829*; b: *Montoya 3993*). Bar = 10 mm.

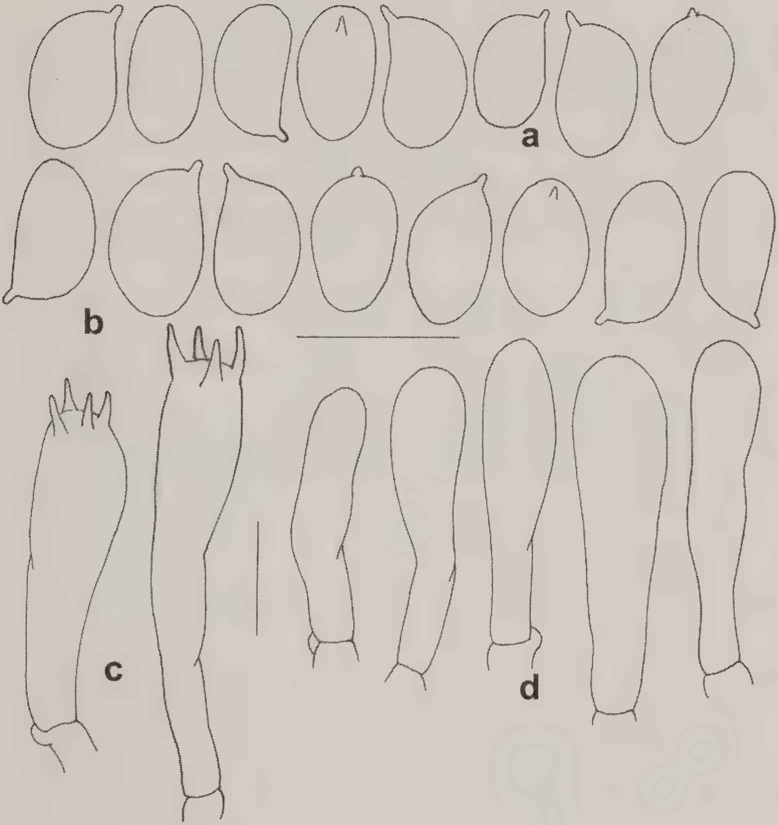

Fig. 5. ***Hygrocybe virescens***. a-b: basidiospores; c: basidia; d: hymenial marginal elements (a, c, d: *Montoya 3829*; b: *A.H. Smith 56649* (*Holotype*). Bar = 10 μm.

The collections studied from Mexico fit the type macro and microscopic variation. Basidiomes of this species are peculiar regarding the color variation, mimetic to the accompanying flora. It should be mentioned, that current collections have been the first carried out in the area, although we have been doing field work there for at least 15 years. In the sites of collection the species grows below grass, and in fact, it is difficult to distinguish it. The basidiomes also imitate decaying clovers. According to Hesler and Smith (1963), *H. virescens* grows under redwood. The specimens studied were found in both localities near *Cupressus* hedges. The sites of collection occupy areas originally covered by cloud forest, the Botanical Garden is currently surrounded by remains of that forest.

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MYCOTAXON

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Taxonomy of *Ophiostoma radiaticola* sp. nov. (*Ophiostomatales,* Ascomycetes), the teleomorph of *Pesotum pini,* isolated from logs of *Pinus radiata*

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Abstract—A new *Ophiostoma* species causing sapstain was isolated from *Pinus radiata* logs grown and stored in New Zealand, and imported from New Zealand to Korea. *Ophiostoma radiaticola* produces dark ascomata with long necks, lacks ostiolar hyphae and has hyaline reniform ascospores with a hat-shaped sheath. The fungus has mononematous *Leptographium*-like conidiophores that intergrade with synnematous *Pesotum*-like conidiophores, the latter previously described under the anamorph name *Pesotum pini* Mating tests on pine sapwood wafers demonstrated that *O. radiaticola* is a heterothallic species with two mating types. Phylogenetic analyses of aligned ITS 2/partial LSU rDNA, partial β-tubulin and partial actin DNA sequences demonstrate that *O. radiaticola* is a phylogenetically distinct species most closely related to *O. cainii* and *O. galeiformis*, with which it shares many morphological characters. It is also more closely related to *Ophiostoma* species with *Leptographium* anamorphs than to species of the *O. piceae* and *O. ulmi* complexes, the best-known groups of species with *Pesotum* anamorphs.

Key word—radiata pine, sapstain, *Pesotum, Ophiostoma cainii, Ophiostoma galeiformis*

Introduction

Originating in a small area of coastal south western USA, radiata pine (*Pinus radiata* D. Don) is now the most important lumber species in New Zealand (1.33 million ha), Chile (1.36 million ha), Australia (720,000 ha) and Spain (260,000 ha) and is widely used in many Asian countries, particularly Korea and Japan (Price 1997). The tree and its wood are susceptible to fungal attack, and there are active studies of sapstain fungi underway in countries growing or importing radiata pine. In New Zealand, surveys of sapstaining fungi that included radiata pine were undertaken by Hutchison & Reid (1988a, b), and Farrell et al. (1997), and additional species were reported in recent taxonomic literature (Jacobs & Wingfield 2001).

Many species of the ascomycete genus *Ophiostoma* cause blue-stain in logs and lumber, and those that have been reported from *P. radiata* in New Zealand are listed in Table 1. Other species cause diseases of living, standing trees (Boyce 1961, Wingfield & Gibbs 1991), or are associated with root diseases and vascular wilt diseases such as Dutch Elm Disease (Harrington 1988, 1993, Wingfield et al. 1988, Wingfield et al. 1993). Many *Ophiostoma* species are vectored by bark beetles (Coleoptera: Scolytidae) that infest species of *Pinus* and other conifers (Harrington 1988, 1993, Wingfield et al. 1993). *Ophiostoma* presently includes slightly more than 100 species, characterized by the production of superficial, generally darkly pigmented, thin-walled ascomata with evanescent asci produced in a dark globose base, with variously-shaped ascospores in most species exuding from a long, ostiolate neck. The genus is well-known for its diversity of anamorphs, and the taxonomic controversies that have surrounded both the teleomorph and the anamorphs (Wingfield et al. 1993). Presently, mycelial anamorphs are classified in *Sporothrix* Hekt. & Perk. and *Hyalorhinocladiella* Upadh. & Kendr., macronematous anamorphs are classified in *Leptographium* Lagerb. & Melin, and synnematous anamorphs are classified in *Pesotum* Crane & Schokn. (and sometimes also in *Phialographium* Upadh. & Kendr.).

Molecular phylogenetic studies combined with the application of biological species concepts derived from *in vitro* mating tests have begun to reveal the infrageneric structure of *Ophiostoma* and are resulting in more robust species concepts. In general, there is good correlation between monophyletic clades based on phylogenetic analysis of rDNA alignments and groups distinguished by combinations of ascomatal, ascospore and anamorph characters. The structure and species composition of two fairly large clades within the genus are now relatively clear. The *Piliferum* clade includes species mostly with dark, long-necked ascomata with ostiolar hyphae, with orange-section shaped ascospores lacking a sheath, with *Sporothrix* anamorphs and in many of the species also a synnematous *Pesotum* anamorph. This clade includes the type species of *Ophiostoma*, *O. piliferum*, as well as several other species complexes. These comprise complexes of reproductively isolated, sometime geographically isolated, sibling species that are often distinguished by only inconspicuous morphological characters. Included are the *O. piliferum* complex (Schroeder et al. 2001), the Dutch Elm Disease complex (Brasier 1993, Brasier & Mehrotra 1995), the *O. piceae* complex (Brasier 1993, Harrington et al. 2001), and the *O. minus* complex (Gorton & Webber 2000, Jacobs & Kirisits 2003). A second major clade, the *Leptographium* clade, includes *Ophiostoma* species with macronematous *Leptographium* anamorphs, and several apparently strictly anamorphic species (Jacobs et al. 2001). To date, less work has been done on elucidating biological species in this clade and it is likely that complexes of sibling species in this group remain to be discovered. Our study focuses on some species in this second major clade.

Recently, we isolated an unidentified *Ophiostoma* species from radiata pine logs in New Zealand and from logs imported from New Zealand into Korea. This species was distinctive in having an anamorph with a continuum of morphologies between *Leptographium* and *Pesotum*. We compared the morphological and molecular features of this unidentified species with *O. cainii* (Olchow. & J. Reid) T.C. Harr. and *O. galeiformis* (B.K. Bakshi) Math.-Käärik, two species with similar ascospores and a similar combination of anamorphs, and the anamorphic species *Pesotum pini* (Hutchison & Reid) Okada & Seifert. The fungus is described here as a new heterothallic species, *O. radiaticola*, the teleomorph of *P. pini*.

Table 1. *Ophiostoma* species and related anamorphs reported on *Pinus radiata* in New Zealand in previous studies

Species	Reference
L. euphyes Jacobs & Wingf.	Jacobs & Wingfield 2001
L. lundbergii Lagerb. & Melin	Jacobs & Wingfield 2001
L. procerum (Kendr.) Wingf.	Farrell et al. 1997, Jacobs & Wingfield 2001
L. truncatum (Wingf. & Mararas) Wingf.	Farrell et al. 1997, Jacobs & Wingfield 2001
Ceratocystis coronata Olchow. & Reid	Hutchison & Reid 1988a, Farrell et al. 1997
O. flocossum Math.-Käärik	Farrell et al. 1997
O. huntii (Rob.-Jeff.) Hoog & Scheffer	Farrell et al. 1997, Jacobs & Wingfield 2001
O. ips (Rumbold) Nannf.	Hutchison & Reid 1988a, Farrell et al. 1997
O. piceae (Münch) H. & P. Sydow	Hutchison & Reid 1988a, Farrell et al. 1997
O. piceaperdum (Rumbold) Arx	Hutchison & Reid 1988a, Jacobs & Wingfield 2001
O. piliferum (Fr.) H. & P. Sydow	Hutchison & Reid 1988a, Farrell et al. 1997
O. pluriannulatum (Hedg.) H. & P. Sydow	Farrell et al. 1997
O. quercus (Georg.) Nannf.	Farrell et al. 1997
O. setosum Uzunovic et al.[1]	Farrell et al. 1997
O. stenoceras (Robak) Melin & Nannf.	Farrell et al. 1997

[1] Reported as "*Graphium* sp. with black-veined synnema"

Materials and methods

Morphological and cultural studies

Cultures were isolated from stained radiata pine logs during the winters of 1998–2000 in Korea by Kim & Kim (2000) and Kim (2001). Four strains (NZFS 559, 613, 1080, 3534, and 5190) originating from radiata pine in New Zealand were obtained from Mrs. M. Dick (NZFS, Forest Research Culture Collection, Rotorua, New Zealand). Representative cultures are maintained in the Culture Collections of Korea University (KUC, Seoul, Korea), the Breuil Culture Collection (University of British Columbia, Vancouver, BC, Canada), and in the Canadian Collection of Fungal Cultures (DAOM, Ottawa, ON, Canada).

For morphological studies, cultures were grown on 2% Malt Extract Agar (D-MEA, 20 g Difco malt extract, 15 g Difco agar, and 1000 mL distilled water). Growth rates were determined at 5 C intervals between 5 and 35 °C. Agar disks (5 mm in diameter) taken from the edge of a freshly grown colony were placed on 2% D-MEA media in 90 mm Petri dishes with three replicates per isolate. Colony diameter on each plate was measured 3, 5, and 7 days after inoculation, respectively. Growth rates were calculated in mm per day. Cycloheximide tolerance of isolates was examined by measuring their growth at 25 °C on D-MEA amended with different concentrations (0.05, 0.1, and 0.5%) of cycloheximide (Aldrich chem. Co., WI, USA).

Morphological observations were made on fungal structures produced on 2% D-MEA and sterile lodgepole pine sapwood wafers. For light microscopy, fungal structures were mounted in water or 90% lactic acid and observed using a Zeiss Axioplan or an Olympus BX50 light microscope. Means ± standard error (se) statistics are based on 25 measurements per structure. For scanning electron microscopy (SEM), small wood blocks (10 x 2 x 7 mm) covered with conidiophores were fixed in 2.5% glutaraldehyde in 0.05 M sodium cacodylate at pH 7.1. All fixation procedures were performed within 1 hr under vacuum. The samples sat for 1 min, were microwaved for 40 s at 212 watts, and held for 3 min. Then the samples were rinsed with buffer (0.05 M cacodylate, pH 7.1) for 5 min, microwaved for 40 s, and then fixed with 2% osmium tetroxide. After a brief rinse with sterilized water, the samples were dehydrated in a grade ethanol series (50, 70, 85, 95, 100, and 100%). For each ethanol series, the samples sat for 1 min and were then microwaved for 40 s at 115 watts. After fixation, the samples were dried with a Balzers CPD 020 critical point drier, coated with a Nanotech Semprep II sputter coater, and examined using an Hitachi S4700 scanning electron microscope.

Mating experiments

Sterile lodgepole pine (*Pinus contorta* var. *latifolia* Engelm.) sapwood wafers were used for mating tests, following the method of Brasier (1981). The wood was placed directly on 1% agar media to maintain moisture content. Three types of mating experiments were undertaken. All single spore isolates of *O. radiaticola* were crossed, single spore isolates of *O. galeiformis* were crossed, and strains of the two species were crossed with each other in all possible combinations and then incubated, for 4-5 weeks at room temperature. Single ascospore isolates subsequently obtained from the progeny of such crosses were backcrossed to the parental mating strains to confirm the fertility of the F1 generation. In addition, single strains of each species were inoculated onto test blocks to test for homothallic ascomatal formation.

DNA extraction, PCR, sequencing and phylogenetic analysis

For genomic DNA preparation, cultures were inoculated on 2% Oxoid MEA (O-MEA) overlaid with sterile cellophane sheets (Bio-Rad) and grown for 7 days at room temperature. DNA extraction was carried out using the methods described by Kim et al. (1999).

The internal transcribed spacer (ITS) 2 and partial large subunit (LSU) regions of the ribosomal DNA operon (rDNA) were amplified using the primers ITS3 and LR3 (Vilgalys & Hester 1990, White et al. 1990). Amplification of part of the actin gene was done with the primers Lepact F and Lepact R (Lim et al. 2004). A part of the β-tubulin gene was amplified using the primers Bt2E (5'-GTT CAY CTC CAG ACC GCY CAG TG-3') and BT12 (Kim et al. 2003). PCR amplification was performed as described by Lee et al. (2003). PCR products were visualized by electrophoresis on a 1.4 % agarose gel containing ethidium bromide. The PCR products were purified using a Qiaquick PCR Purification Kit (Qiagen, Mississauga, Ontario). Purified PCR products were sequenced using the same primer sets described above. Sequencing was performed on an ABI 3700 automated sequencer (Perkin-Elmer Inc. Foster City, California) at the DNA synthesis and Sequencing Facility, MACROGEN (Seoul, Korea). Sequences were proofread and edited using the PHYDIT program version 3.2 (http://plasza.snu.ac.kr/~jchun/phydit/). The new sequences derived in this study are indicated by bold type in Figs 16 and 17. Three different data sets were assembled and aligned including other ophiostomatoid fungi retrieved from GenBank (accession numbers in normal type in Figs. 16, 17).

For phylogenetic analysis, the three data sets representing the three gene regions sequenced were aligned using Clustal X program (Thompson et al. 1997) and then optimized using the PHYDIT program version 3.2. Ambiguous regions of the rDNA alignment and intron regions of actin and β-tubulin genes were excluded from analyses. Based on previous phylogenetic analyses (Ayliffe et al. 2001, Jacobs et al. 2001, Spatafora & Blackwell 1994), the phylogenetic trees of the rDNA, the actin and the β-tubulin genes were rooted with *Ophiostoma ips* (AY194934), *O. ulmi* (Buisman) Nannf. (AF378563), and *O. ips* (AY194950), respectively. All parsimony analyses used the heuristic search option with simple addition sequences with TBR branch swapping and MULPARS turned on. Gaps were treated as missing data. Branch stability was assessed by 1000 replicate bootstrap replications using heuristic searches as implemented in PAUP*4.0b10 (Swofford 2001).

Results

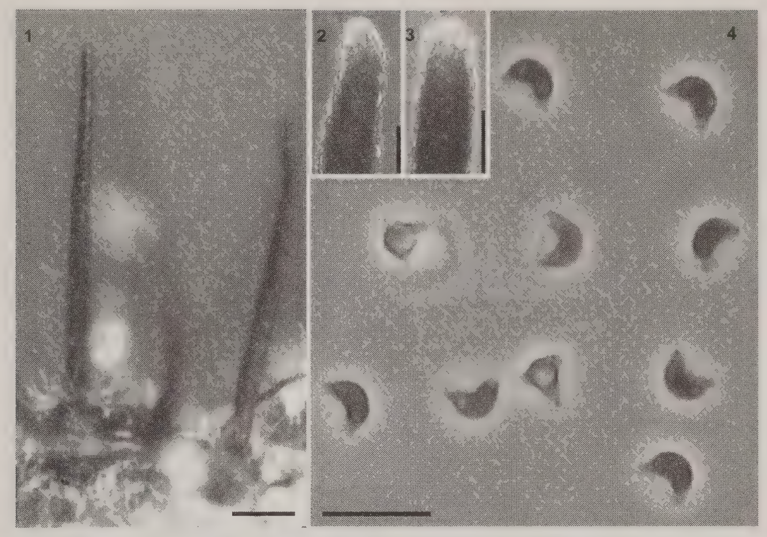
Taxonomic description

Ophiostoma radiaticola J.-J. Kim, Seifert & G.-H. Kim, **sp. nov.** Figs. 1–14.
Anamorph: *Pesotum pini* (Hutchison & Reid) Okada & Seifert, Can. J. Bot. 76: 1504. 1998.
≡ *Hyalopesotum pini* Hutchison & Reid, N. Z. J. Bot. 26: 90. 1988.

> *Species similis Ophiostomatis cainii et Ophiostomatis galeiformis sed genetice isolata, heterothallica. Ascomata atra, e basi globosa, 200–300 µm diam., et collo 300–960 µm alto composite; collum ad basim 40–50 µm, in crista hypharum ostiolarium absente. Asci non visi. Massa ascosporarum apicalis mucida vel in cirrhum, alba. Ascosporae hyalinae, reniformes vel allantoideae, 4–4.5 × 1.5–3 µm, vagina gelatinosa circumdatae, vagina a latere visa cucullata et e polo triangulais. Conidiomata synnematica typica generis Pesoti, basi fusca vel atra, 400–680 µm alta, 15–150 µm lata. Conidiophora penicillata, biverticillata vel terverticillata. Cellulae conidiogenae cylindricae vel subulatae, 6.5–20.5 × 1.5–2 µm, phialidicer vel percurrenter vel sympodialiter proliferentes. Massa conidiorum apicalis mucida, alba, flava vel armeniaca. Conidia 3–6.5 × 1.5–2 µm, oblongo-ellipsoidea vel plusminusve clavata. Conidiophora et conidia typica generis Leptographii similis conidiophora in synnematicis. Culturae in extracto malti 'Difco' 25 C in dies circa 2.7 mm radii crescentes.* ***Holotypus*** *in ligno Pini contorae, combinatio culturarum purarum compatibilium KUC2036 et NZFS1080, herb. DAOM no. 234021.*
>
> ***Etymology***: *radiaticola,* indicating growth on radiata pine.

Ascomata developing about 4 weeks after pairing of two sexually compatible strains on sterilized lodgepole pine wafers, not produced on agar; sparse, solitary, superficial, intermingled with the anamorph; the base dark brown to black, smooth, globose, collapsing cupulate when dry, 200–300 µm diam (mean ± se = 255 ± 30), with pale brown hyphae making the surface appear somewhat hairy, the surface composed more or less textura angularis of brown cells up to 3–15 µm in their longest dimension, the walls irregularly thickened up to 1.5 µm thick, with irregular deposits of darker pigment; the neck black, light brown near the apex, smooth under the dissecting scope but somewhat scurfy under higher magnification, curved or straight, subulate, 300–960 µm long (mean ± se = 740 ±194), 40–50 µm wide (mean ± se = 49 ± 3.2) at the base, 10–15 µm wide at the tip; composed of more or less parallel hyphae, individually brown, opaque in mass, 2–3.5 µm wide, frequently septate, constricted at the septa; becoming paler abruptly at the tip of the neck; ostiolar hyphae absent. Asci not observed. Ascospore masses extrude in a thick, whitish mass, globose to cirrhus-like. Ascospores 4–4.5 × 1.5–3.0 (mean ± se = 4.5 ± 0.4 × 2.8 ± 0.8) µm, reniform in side view often with one strongly concave surface, appearing hat-shaped because of triangular sheath extensions at the ends, ellipsoidal in face view, round or ellipsoidal in end view but appearing triangular because of the sheath, sheath up to about 1–1.5 µm thick.

Synnemata solitary or gregarious, 400–680 µm tall (mean ± se = 535 ± 86), 15–150 µm wide at the base, the stipe cylindrical or subulate, pale to dark brown or black at the base, reddish brown towards the apex. Hyphae of stipe 2.5–4 µm wide at the base, brown to olivaceous, with walls 0.5–1 µm thick, and 2–3 µm below the capitulum, olivaceous,



Figs. 1–4. *Ophiostoma radiaticola*, teleomorph, from the holotype. 1. Ascomata on wood blocks. 2, 3. Ostiolar regions of two ascomata, showing absence of ostiolar hyphae. 4. Ascospores showing hat-shape in side view, and triangular shape of the ascospores in end view. Scale bars: Fig. 1 = 200 *μ*m; Figs. 2, 3 = 20 *μ*m; Fig. 4 = 10 *μ*m.

with the walls slightly thickened, and thin septa present. Conidiophore branching biverticillate to terverticillate, lower whorls often with 2 branches, conidiogenous apparatus 42.5–80.5 (mean ± se = 61.2 ± 13.4) μm long, basal branches 9.5–31.5 (mean ± se = 19.1 ± 5.7) × 1.5–2.5 μm, cylindrical, brown, secondary branches 8.0–16.0 (mean ± se = 12.5 ± 2.7) × 2.5–3 μm, metulae hyaline, 9.5–14.0 (mean ± se = 11.3 ± 1.6) × 1–3 μm. Conidiogenous cells proliferating sympodially or percurrently, in whorls of 2–3, 6.5–20.5 (12.4 ± 3.8) × 1.5–2 μm, more or less cylindrical or subulate, sometimes uneven in outline, the walls usually slightly thickened at the base, conidiogenous aperture 1–1.5 μm wide, apparent periclinal thickening and slightly flared collarette visible only with phase contrast. Conidial mass white, light yellow or light orange when dry, pale brown when dry, globose, turbinate, ovate or ellipsoidal, 75–125 μm diam. Conidia aseptate, varying greatly in size but more or less uniform in shape, 3.0–6.5 × 1.5–2.0 (mean ± se = 4.7 ± 0.9 ×1.6 ± 0.2) μm, oblong-ellipsoidal to cylindrical, sometimes clavate, L/B 1.8–2.8, sometimes slightly curved, base often somewhat truncate.

Mononematous anamorph *Leptographium*-like, solitary or in all intermediate forms to complete synnemata, or emerging as a terminal extension to a short synnema. When mononematous, usually with a tightly appressed, longer conidiogenous apparatus 200–500 (x mean ± se = 325 ± 97) μm; stipe straight or flexuous, pale to dark brown, 5–10 septate, 3.0–5.0 (mean ± se = 4.3 ± 0.6) μm wide at the base. Conidia identical to those in synnemata.

The optimal growth temperature for *O. radiaticola* was 25 °C with a growth rate of 2.7 mm/day on 2% D-MEA. No growth was observed below 10 °C or above 35 °C. On cycloheximide (0.05, 0.1, and 0.5%)-amended MEA, the mean growth rates of three isolates of *O. radiaticola* were 2.2, 2.0, and 1.4 mm per day, respectively.Colonies were effuse, spreading, first white, becoming olivaceous brown (4E8) on D-MEA. Hyphae mostly immersed, hyaline to subhyaline, smooth, 1.5–4.5 μm thick.

SPECIMENS AND CULTURES EXAMINED: HOLOTYPE: Mating between the cultures KUC 2036 and NZFS 1080, listed below (DAOM 234021) KOREA. INCHEON: *Pinus radiata* logs imported from New Zealand, March 2000, J.-J. Kim and G.-H. Kim, KUC 2036 (DAOM 233237); *Pinus radiata* logs imported from New Zealand, March 2000, J.-J. Kim and G.-H. Kim, KUC 2037. NEW ZEALAND: *Pinus radiata* 1994, M. Dick, NZFS 3534; *Pinus radiata* 1997, M. Dick, NZFS 5190; *Pinus radiata* 2001, M. Dick, NZFS 559, NZFS 613 (DAOM 233239). *Pinus radiata*, M. Dick, NZFS 1080. HOLOTYPE of *Hyalopesotum pini*, on *Pinus radiata*, J. Reid no. 88, New Zealand, near Onemana, Tairua State Forest, Coromandel, 20 May 1982 [WIN(M)].

Mating experiments

Isolates of *O. radiaticola* segregated clearly into two mating types. The ascomata from these crosses were fertile and single ascospore progeny were easily obtained. Randomly selected single ascospore progeny, when mated against either parent, also produced viable ascomata. *O. radiaticola* is heterothallic, and single ascospore isolates do not produce ascomata. Of the isolates used in these experiments, *O. radiaticola* KUC2036 and NZFS613 and the ex-type culture of *Pesotum pini* (UAMH9691) were of the (+) mating type and the others were (-) mating type (Table 2).

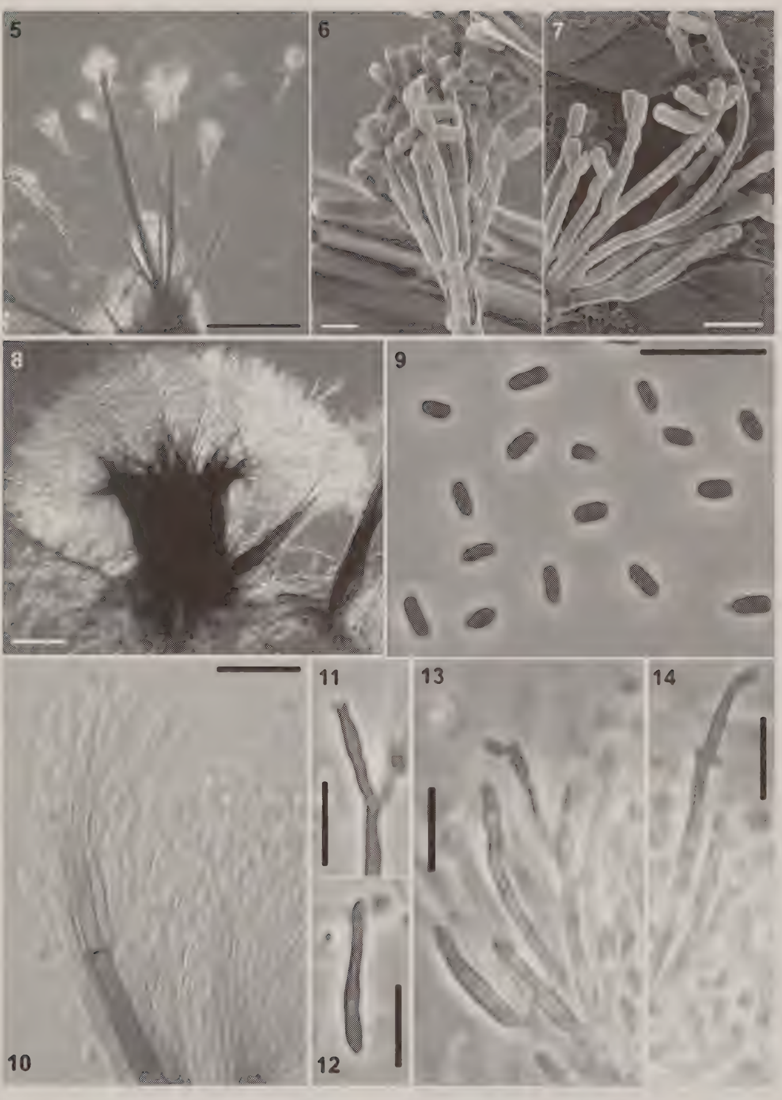
Table 2. Mating experiments of *Ophiostoma radiaticola*.[a]

	Recipient strain							
Donor strain	A	B	C	D	E	F	G	H
KUC2036 (A)	–[b]	–	–	+	+	+	+	+
NZFS613 (B)	–	–	–	+	+	+	+	+
UAMH9691 (C)	–	–	–	+	+	+	+	+
KUC2037 (D)	+	+	+	–	–	–	–	–
NZFS1080 (E)	+	+	+	–	–	–	–	–
NZFS559 (F)	+	+	+	–	–	–	–	–
NZFS5190 (G)	+	+	+	–	–	–	–	–
NZFS3534 (H)	+	+	+	–	–	–	–	–

[a] The strains in bold are (+) mating type and the others are (-) mating type.

[b] + indicates formation of ascomata with viable ascospores; – indicates no ascomata.

In our experiments, the three strains of *O. galeiformis*, CMW5290 (ex-epitype), CMW4447, and CMW4426 appeared to be homothallic. There was no evidence of mating between *O. radiaticola* and *O. galeiformis*, although this was difficult to interpret with certainty because of the homothallism of the latter species.



Figs. 5–14. *Ophiostoma radiaticola*, anamorphs, from holotype and ex-type culture. 5. *Leptographium*-like conidiophores from D-MEA. 6, 7. SEM micrographs of *Leptographium*-like conidiophores, showing percurrent and false-sympodial proliferation of conidiogenous cells. 8. *Pesotum*-like synnemata from D-MEA culture. 9. Conidia. 10. Conidiophores from synnemata, with DIC. 11-14. Conidiogenous cells from synnemata, with phase contrast, showing collarette-like flaring apparently representing phialidic conidiogenous cells. Scale bars: Fig. 5 = 100 μm; Figs. 6, 7 = 5 μm; Fig. 8 = 50 μm; Figs. 9-14 = 10μm.

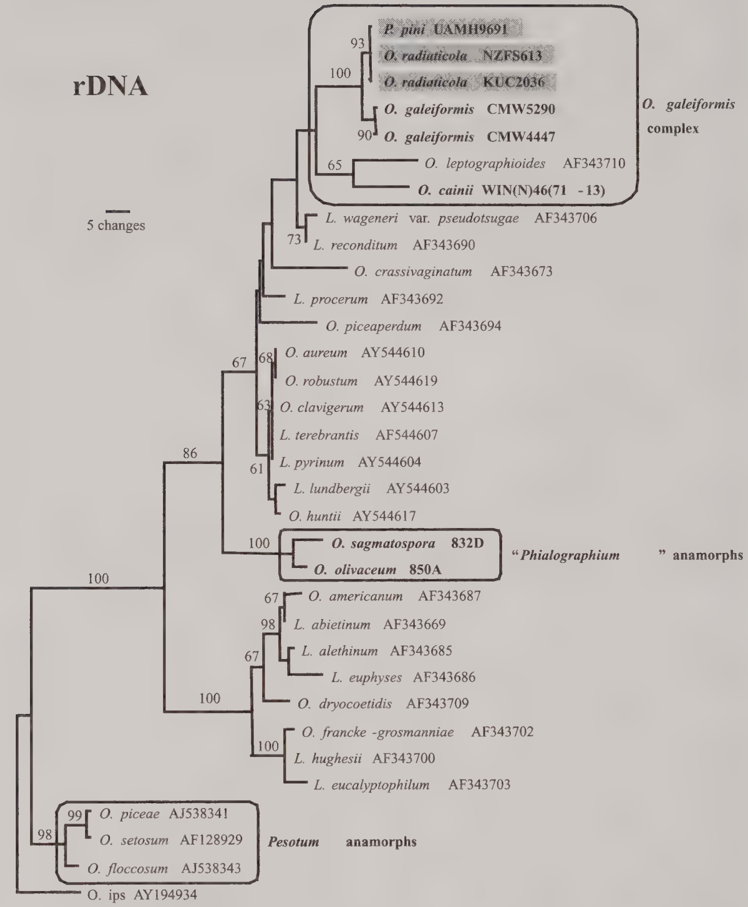
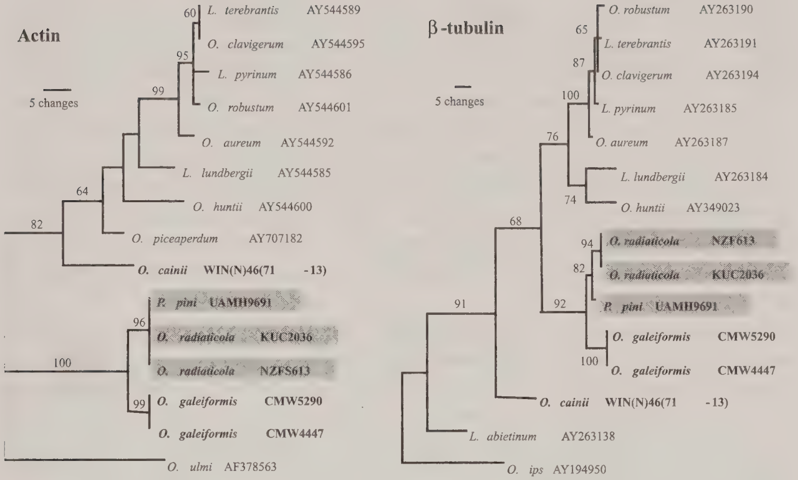

rDNA
5 changes
93
100
P. pini UAMH9691
O. radiaticola NZFS613
O. radiaticola KUC2036
O. galeiformis CMW5290
90
O. galeiformis CMW4447
65
O. leptographioides AF343710
O. cainii WIN(N)46(71 -13)
O. galeiformis complex
L. wageneri var. pseudotsugae AF343706
73
L. reconditum AF343690
O. crassivaginatum AF343673
L. procerum AF343692
O. piceaperdum AF343694
67
68
O. aureum AY544610
O. robustum AY544619
63
O. clavigerum AY544613
L. terebrantis AF544607
61
L. pyrinum AY544604
86
L. lundbergii AY544603
O. huntii AY544617
100
O. sagmatospora 832D
O. olivaceum 850A
"Phialographium" anamorphs
100
67
O. americanum AF343687
98
L. abietinum AF343669
67
L. alethinum AF343685
L. euphyses AF343686
100
O. dryocoetidis AF343709
O. francke -grosmanniae AF343702
100
L. hughesii AF343700
L. eucalyptophilum AF343703
99
O. piceae AJ538341
98
O. setosum AF128929
O. floccosum AJ538343
Pesotum anamorphs
O. ips AY194934

Fig. 15. Phylogenetic tree based on rDNA sequences, showing the relationships among *O. radiaticola* and its anamorph *P. pini*, *O. galeiformis* and *O. cainii*, and the position of this clade among other *Ophiostoma* species. Species with *Pesotum* or "*Phialographium*" anamorphs are indicated; other species have *Leptographium* anamorphs. Numbers on selected branches represent bootstrap values above 60%. The tree had the highest log-likelihood value among 62 equally parsimonious trees. The three branches with arrows would collapse in the strict consensus tree based on the MPTs. GenBank accession numbers obtained in this study are as follows: *P. pini* UAMH9691 (AY744549); *O. radiaticola* NZFS613 (AY744550), KUC2036 (AY744551); *O. galeiformis* CMW5290 (AY744552), CMW4447 (AY744553); *O. cainii* WIN(N)46(71-13) (AY744548); *O. sagmatospora* 832D (AY744546); and *O. olivaceum* 850A (AY744547).


Actin
5 changes
L. terebrantis AY544589
O. clavigerum AY544595
L. pyrinum AY544586
O. robustum AY544601
O. aureum AY544592
L. lundbergii AY544585
O. huntii AY544600
O. piceaperdum AY707182
O. cainii WIN(N)46(71-13)
P. pini UAMH9691
O. radiaticola KUC2036
O. radiaticola NZFS613
O. galeiformis CMW5290
O. galeiformis CMW4447
O. ulmi AF378563
60
95
99
64
82
96
100
99
β-tubulin
5 changes
O. robustum AY263190
L. terebrantis AY263191
O. clavigerum AY263194
L. pyrinum AY263185
O. aureum AY263187
L. lundbergii AY263184
O. huntii AY349023
O. radiaticola NZF613
O. radiaticola KUC2036
P. pini UAMH9691
O. galeiformis CMW5290
O. galeiformis CMW4447
O. cainii WIN(N)46(71-13)
L. abietinum AY263138
O. ips AY194950
65
87
100
76
74
68
94
82
91
92
100

(a) (b)

Fig. 16. Actin and β-tubulin gene trees of a subset of taxa including the *O. galeiformis* complex, confirming the conspecificity of *O. radiaticola* and its anamorph *P. pini*, and its sister species relationship with *O. galeiformis*. GenBank accession numbers for actin^a and β-tubulin^b gene obtained in this study are as follows: *P. pini* UAMH9691 (AY744554^a, AY744560^b); *O. radiaticola* KUC2036 (AY744555^a, AY744562^b), NZFS613 (AY744556^a, AY744561^b); *O. galeiformis* CMW5290 (AY744557^a, AY744563^b), CMW4447 (AY744558^a, AY744564^b); and *O. cainii* WIN(N)46(71-13) (AY744559^a, AY744565^b).

Sequence alignments and phylogenetic analyses

The alignment of rDNA sequences containing ITS 2 region and 5' partial LSU region included 33 sequences representing 30 taxa (Fig. 15). After the introduction of gaps, the alignment included 658 nucleotide positions. Areas of ambiguous alignment were excluded from the analysis, and of the remaining 592 characters, 434 characters were constant, 44 were parsimony-uninformative, and 114 characters were parsimony-informative. Parsimony analysis of the rDNA sequences yielded 62 most parsimonious trees (MPT), for which the tree length (TL) was 303 steps, the consistency index (CI) was 0.7096, and the retention index (RI) was 0.8726. The tree shown in Figure 16 had the highest log-likelihood value (-lnL = 2602.15736) of the 62 MPTs.

Phylogenetic analyses using the rDNA data set demonstrated that some species with *Phialographium* anamorphs were related to the *Leptographium* clade, and suggested that *O. radiaticola*, with its mixed phialidic and sympodial synematous anamorphs, was a distinct species, closely related to *O. galeiformis* (Fig. 15). The three rDNA sequences of the *O. radiaticola* were identical and 98.9% similar to the two identical sequences of *O. galeiformis*. These species were also closely related to *O. cainii* and *O. leptographioides* (R.W. Davidson) Arx. Because of the smaller number of sequences in GenBank, parsimony analyses of actin and β-tubulin genes sequences were undertaken for a subset of taxa closely related to *O. radiaticola*. Following the exclusion of intron regions, the alignment of the partial actin/β-tubulin genes included 677/550 nucleotide characters, of which 574/440 were constant, 42/38 were parsimony-uninformative, and 60/72 characters were parsimony-informative. Parsimony analyses of the partial actin/β-tubulin genes both yielded a single MPT (TL=148/184, CI=0.8041/0.7283, RI=0.8802/0.7917). MPTs for each of the actin and β-tubulin gene data sets are shown in Figure 16a and 16b, respectively. In these trees, the three isolates representing the new species constituted a distinct clade with highly supported bootstrap values alongside *O. galeiformis*.

The three molecular data sets were completely congruent concerning the relationships among *O. radiaticola, O. galeiformis*, *O. cainii* and *Pesotum pini*. *Ophiostoma radiaticola* was a sister group to *O. galeiformis* in all analyses, with the ex-type culture of *P. pini* grouping with the former species in all analyses. The position of the morphologically similar *O. cainii* was less clear, forming a poorly supported sister group along with *O. leptographioides* to *O. radiaticola* and *O. galeiformis* in the rDNA tree, placed basal to this clade in the β-tubulin tree, and in a separate clade in the actin tree.

Discussion

Ophiostoma radiaticola is characterized by the production of slightly hairy, black ascomata with long black necks, lacking ostiolar hyphae, and with reniform ascospores surrounded by a sheath. It produces a gradation between mononematous *Leptographium*-like anamorphs and synnematous *Pesotum*-like anamorphs, producing identical conidia and conidiogenous cells. The conidiophores are unusual for having a mixture of phialidic (Figs. 11-14) and sympodially proliferating (Figs. 6, 7) conidiogenous cells. Hutchison and Reid (1988b) commented on this apparent mixture of conidiogenous types in *Pesotum pini*, suggesting that younger conidiogenous cells were phialidic, and became more typically sympodial as the conidiogenous locus proliferated. Based on our mating experiments, *O. radiaticola* meets the criteria as a distinct biological species, and the concordance among the three gene trees meet the criteria of the phylogenetic species concept (Taylor et al. 2000).

Ophiostoma radiaticola belongs to a group of three morphologically similar species with *O. cainii* and *O. galeiformis*, and we have provided a key to these three species below. Zhou et al. (2004) referred to this as the *O. galeiformis* complex, which we believe is appropriate because this is the oldest species name in the group. Each species has ascomatal necks lacking ostiolar hyphae, similar kidney shaped ascospores surrounded by a sheath that makes them seem hat-shaped in side view and triangular or quadrangular in end view, and macronematous anamorphs with oblong-ellispoidal, truncate conidia that vary considerably in size. In cultures of all three species, the anamorph is a mixture of mononematous, *Leptographium*-like conidiophores and synnematous conidiomata that could be ascribed to *Pesotum*. In *O. cainii* and *O. radiaticola*, the anamorph in nature is mostly synnematous; details of the *in vivo* anamorph of *O. galeiformis* have yet to be recorded. This tendency to produce a continuum of anamorphs that could be ascribed to *Leptographium* in the one extreme, and *Pesotum* on the other extreme, has led to some confusion about how to most appropriately name the anamorph of *O. galeiformis* (Wingfield 1993). In fact, the species was not included in the monograph of *Leptographium* by Jacobs and Wingfield (2001), nor in the monograph of *Ceratocystis* and *Ophiostoma* by Upadhyay (1981). Zhou et al. (2004) recently presented a reconsideration of *O. galeiformis*, documenting its global distribution and providing a new description based on freshly isolated cultures. They considered the species heterothallic, although some strains (include the newly designated ex-epitype) appeared to be homothallic. The three strains of *O. galeiformis* that we received from them produced fertile ascomata on wood blocks without mating and thus appear to be homothallic. It is possible that our *O. radiaticola* is identical with the "*O. galeiformis*-like" fungus mentioned by Zhou et al. (2004), which was isolated in Mexico and the USA from three different pine species, including *P. radiata*.

Phylogenetically, *O. radiaticola, O. galeiformis* and *O. cainii* are related to other species with *Leptographium* anamorphs, rather than other species with *Pesotum* anamorphs. The *Leptographium* clade also includes some of the synnematous anamorphs of *Ophiostoma* species that have phialidic conidiogenous cells, which have been ascribed by some authors to *Phialographium*. Harrington et al. (2001) favoured the retention of *Phialographium* as distinct from *Pesotum* (typified by the anamorph of *O. ulmi*, in the Piliferum clade) for phylogenetic reasons. However, the phylogenetic relationship of *Leptographium* and *Phialographium* species evident in our phylogenies, combined with the tendencies of *O. radiaticola* and *O. cainii* to produce a mixture of conidiogenous cell types, leaves the question of whether acceptance of *Phialographium* makes things simpler or more complex. The anamorphs of *O. radiaticola, O. cainii* and *O. galeiformis* could be ascribed to any one of three genera, *Leptographium, Pesotum* or *Phialographium*. We have chosen to leave the anamorphic epithet of our new species in *Pesotum,* suggesting that the holomorph name should be used when discussing these fungi, in line with the recommendation of the International Code of Botanical Nomenclature that discourages the routine proposal of anamorph species names when unambiguous teleomorph names are available (Art. 59, rec. A3, Greuter et al. 2000).

Key to the sibling species of the *O. galeiformis* complex

1. Ascospores mostly less than 4 × 2 um (without sheath) . . . . *O. galeiformis*
1. Ascospores mostly larger than 4 × 2 um (without sheath) 2

2. Ascospore sheaths with four points in end view, synnemata fan-shaped in culture, reddish brown, known only from North America . . . . *O. cainii*
2. Ascospore sheaths triangular in end view, synnemata with distinct stalk in culture, brown to blackish stipe, known from New Zealand and Korea . . . *O. radiaticola*

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Heleococcum alkalinum, a new alkali-tolerant ascomycete from saline soda soils

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Abstract - A new ascomycete was isolated from saline soda soils in Central Asia (Kunkur steppe, Kulunda steppe of South Siberia, N-E Mongolia), and Africa (Kenya). It is described as *Heleococcum alkalinum* sp. nov. The species produces dark brown cleistothecial ascomata, where asci are disorganized and scattered and the ascus walls evanesce when mature. Ascospores are bicellular, brown, thick-walled, without any ornamentation and not constricted at the septum. The anamorph is placed in *Acremonium* sect. *Nectrioidea*. *Heleococcum alkalinum* was isolated on alkaline agar (pH 10-10.5) with carboxymethyl cellulose (CMC). It was a dominant species in samples of soda soils with pH >10 and relatively high salinity. Its radial growth rate was almost equal within the range of pH 6.7-10.8, demonstrating an alkali-tolerant adaptation.

Key words - *Bionectriaceae, Hypocreales,* ascomycetes

Introduction

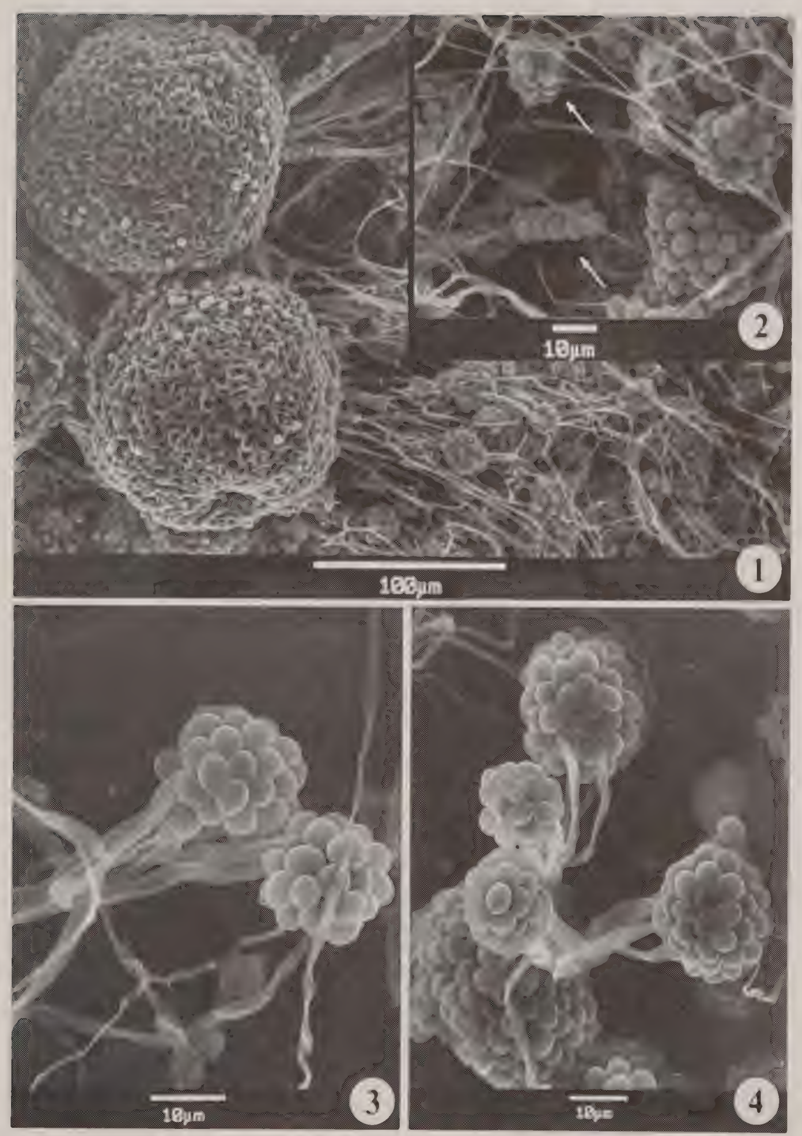
Saline alkaline soils represent unique extreme environments, similar to soda lakes. They contain high to extremely high concentrations of soluble sodium salts, such as sodium carbonate/bicarbonate, sodium chloride and sodium sulfate. Therefore halo-alkaliphilic microorganisms are expected to predominate in such soils. In soda lakes the microbial community is dominated by prokaryotic organisms, particularly anaerobes due to reducing conditions (Jones et al. 1998; Zavarzin et al. 1999). In contrast, the soda soils are dry and aerated most of the time, which favors aerobic micromycetes and actinomycetes. Unfortunately, microbiological studies of soda soils are very scarce.

There are only few reports on fungi growing at alkaline conditions. A *Fusarium* sp. had a wide pH tolerance, it grew at pH 5.0-10.5 (Hiura, Tanimura, 1991). Some alkaliphilic and alkali-tolerant fungi were isolated from alkaline soils of Indonesia (pH 7-8) on alkaline cornmeal agar, pH 9.7. *Acremonium alternatum, A. furcatum, Acremonium* sp., *Gliocladium cibotii, Phialophora geniculata, Stachylidium bicolor* and *Stilbella annulata* were indicated as alkalophilic (Nagai et al., 1995). *Acremonium sp.* and *Chrysosporium* sp., isolated from alkaline calcareous soils in Japan (pH 7.7–8.8), were alkalophiles (Nagai et al., 1998). A new alkalophilic hyphomycete, *Acremonium alkalophilum*, was isolated from sludge of a pig feces compost (Okada et al., 1993). Thus, the ability to grow under alkaline conditions is frequently found in *Acremonium* spp. Almost nothing is known about the micromycetes inhabiting soda soils. Here we report on the occurrence of filamentous fungi in saline alkaline soils.

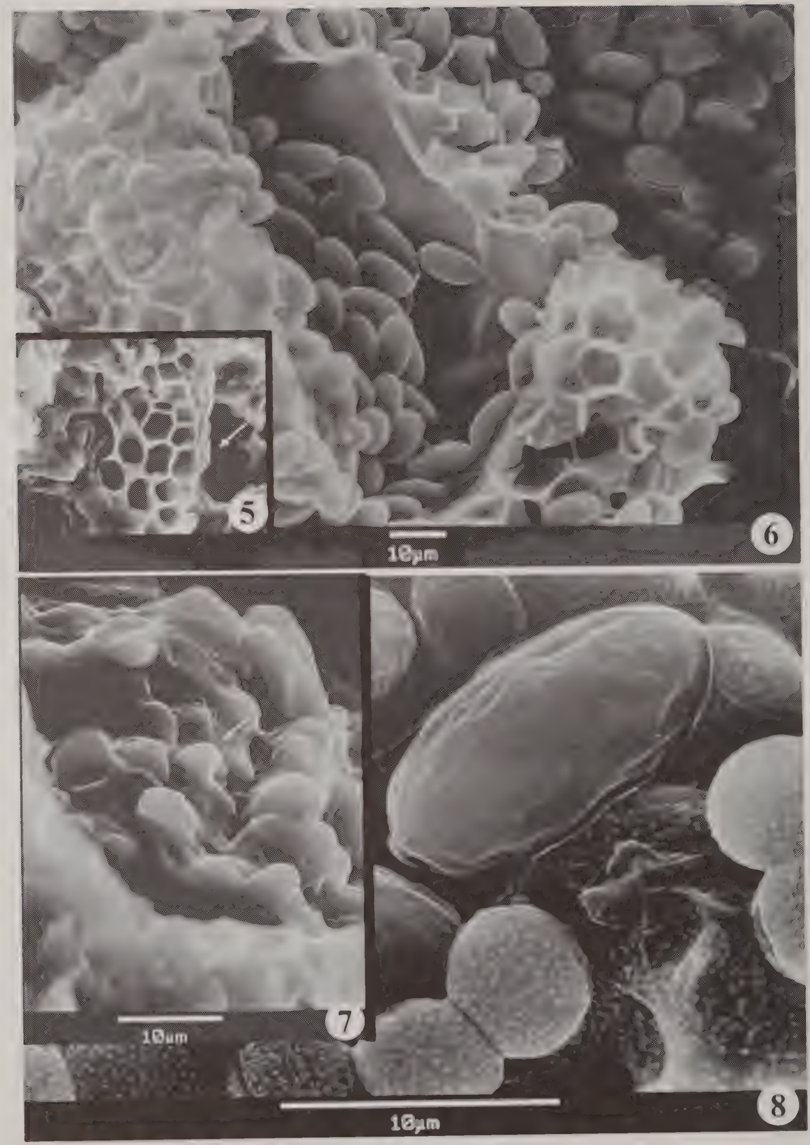
Using alkaline nutritient agar with soda buffer and alkaline agar with CMC we isolated several fungal strains, capable of growth at pH >10 and relatively high salinity. Some of them could partially be identified: *Acremonium* anamorph of *Nectria* sp., *A. alkalophilum, A. charticola, A. strictum, A. rutilum, Acremonium* sp., *Cladosporium sphaerospermum, Mycelia sterilia, Scopulariopsis* anamorph of *Microascus* sp., *Verticillium luteo-album* while the dominant species was unusual. It is described here as a new species, *Heleococcum alkalinum*. The species was isolated from most soil samples and from some halophytic plants growing on soda soils.

Materials and Methods

Top 5 cm samples of saline soda soils were collected in Central Asia (Kunkur steppe in Chita region, Kulunda steppe in Altai, both Southern Siberia), North-eastern Mongolia (Choibalsans region) and Africa (Kenya, near Lake Natron) with pH >10 and relatively high salinities (>5%, w/w). Samples of halophytic plants, *Salicornia europaea, Suaeda* spp., *Halocnemum strobilaceum, Anabasis salsa,* and *Atriplex verrucifera,* abundantly growing on soda soils in Kulunda steppe near soda lakes were also included in the analysis. The samples were put into sterile plastic Falcon tubes and kept at 4°C after returning from the field. Small soil aggregates (10 mg) as well as parts of plants were placed on the surface of an alkaline agar medium (AA), containing (g/l): Na_2CO_3 - 24, $NaHCO_3$ - 6, NaCl - 5, KNO_3 - 1, K_2HPO_4 - 1, $MgSO_4*7H_2O$ – 0.5, yeast extract - 1, starch – 15 or CMC - 2, Difco agar - 20, microelements - 1ml/l. The final medium was prepared by 1:1 mixing of the liquid medium and 4% agar at 50°C to prevent caramelization of the agar. Rifampicin was added at 2 mg/l to repress bacterial growth. Uses of the soda buffer allowed maintain stable alkaline pH within the range 10.0-10.5. The plates were incubated for 2–3 weeks at 23-25°C. Nutrition agar with starch without any antibiotics and malt agar (3.5% of malt extract, Maltax 10 standard, Finland, pH 6.5) were used for species identification. The radial growth rate of 3 isolates *H. alkalinum* was measured within the range of pH 5.8-10.5 on media with soda buffer, malt agar (pH 6.5) and Czapek agar (pH 5.5).



Figs 1-4. *Heleococcum alkalinum* (scanning electron microscopy, media – alkaline agar): 1 – Cliestothecial ascomata, creeping vegetative hyphae and conidiophores with slimy mass of abundant phialoconidia (*Acremonium*-type conidiation); 2 – phialoconidia aggregated into spherical and short-columnar heads; 3 – basitonously verticillate conidiophores with 3-5 branches and spherical heads of conidia.



Figs 5-8. *Heleococcum alkalinum* (scanning electron microscopy, media – alkaline agar): 5 – peridium composed of several layers of angular cells; 6 – ascospore release from the ascocarp. 7 – ascospores accumulated in the venter of the ascocarp which is filled with gelatinous matrix; 8 – Ellipsoid ascospores and subspheric conidia.

Taxonomic Description

Heleococcum alkalinum Bilanenko et Ivanova *sp. nov.* **FIGURES 1-12**

Anamorphosis: Acremonium sp.

Ascomata brunnea, superficialia, globosa, cleistothecia, 120-250 µm diam. Peridium multi-stratosum, pseudoparenchymaticum, plicatum, exoperidium e 3-5 stratis cellularum angularium compositum. Paraphyses absentes. Asci saccati, tenuitunicati, unitunicati, in ascomate sparsi, matrice hyalina immersi. Tunica asci diffluens ante maturitatem. Ascosporae ellipsoideae, 12-15 x 5-7 µm, in medio uniseptatae, haud constrictae, crassitunicatae, dilute brunneae, glabrae.

Coloniae in agaro alcalino (pH 10) fere celeriter crescentes (38-40 mm diam. post 10 dies), in agaro musto malti confecto tarde crescentes (5.5 mm diam. post 10 dies), albae dein copiosis ascomatibus nigro-zonatae. Conidiophora plerumque ex hyphis acriis solitariis vel interdum fasciculatis oriunda. Conidiophora ramos basitone verticillatos vel interdum solitarios ferentia. Phialides 15-60 µm longae sursum angustatae, fere tenuitunicatae. Conidia hyalina, subglobosa vel ellipsoidea, 4.5-5.5 x 4.1-4.6 µm, in capitulis mucilaginosis aggregata, globosa vel interdum breviter cylindrica. Chlamydosporae absentes.

Typus: F 11, isolatus e solo alcalino, pH 10. 5; 1999. Mongolia, in herbario Centraalbureau voor Schimmelcultures (CBS 110278) et Vsesoyusnaya Kollektsia Microorganismov – Fungi (VKM-F 3762) conservatus.

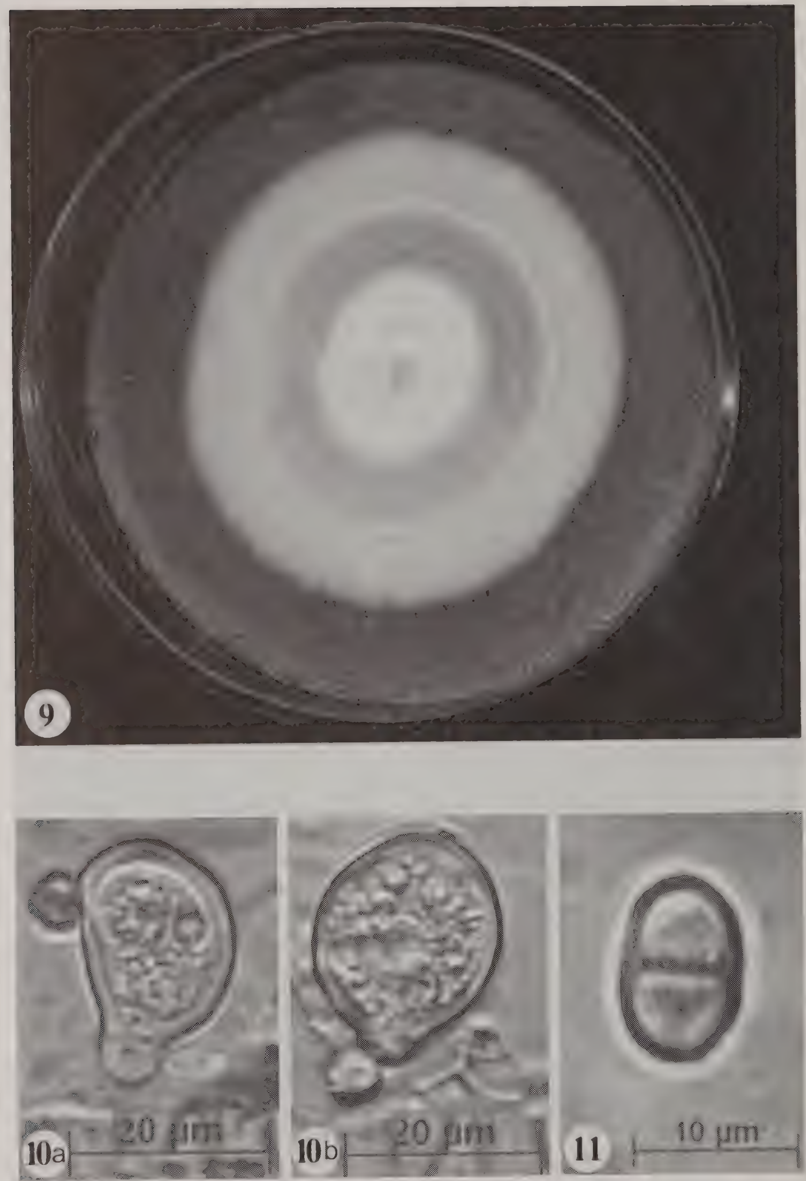
Etymology: from the Latin, *alcalinus* = alkaline.

KEY CHARACTERS - **Colonies** on alkaline agar with starch (AA, pH 10–10.2) rather fast-growing, reaching 38–40 mm diam. in 10 days at 25°C. On malt agar (pH 6.5) growing more slowly, reaching 5.5 mm diam. in 10 days. Young colonies white; later, black concentric zones appearing as a result of formation of abundant ascomata, velvety to woolly. Reverse colorless. Odor pleasant. Exudate absent. Decumbent vegetative hyphae thin-walled, hyaline, 0.5-2.0 µm wide.

Ascomata dark brown, superficial on the substratum, globose, 120–250 µm diam., non-ostiolate, cleistothecial, not changing color in 3% KOH and lactic acid. Peridium multilayered, pseudoparenchymatous, with folded surface, exoperidium composed of 3–5 layers of angular cells. Paraphyses absent. Asci thin-walled, without apical apparatus, saccate, unitunicate, scattered irregulary in the ascocarp, embedded in a gelatinous matrix. Ascospores released by dissolution of the ascus' wall before maturity. Ascospores accumulating within the ascocarp release in a slimy mass, liberated by pressure within the ascocarp.

Ascospores ellipsoidal or ovoid, 12–15 x 5–7 µm, medially 1-septate, not constricted at the septum, thick-walled, pale brown, smooth.

Mycelium consisting of hyaline, smooth-walled, septate, 1–3 µm wide, often fasciculate hyphae. Conidiation abundant, mostly nematogenous, partially plectonematogenous. Conidiophores predominantly basitonously verticillate, rarely with solitary branches. Phialides variable, 15-60 µm long, gradually converging towards the apex, rather thin-walled. Conidia aggregated in slimy masses, mostly spherical, rarely in short columns. Conidia, subglobose or ellipsoidal, 4.5-5.5 x 4.0-4.5 µm, slightly roughened as observed by SEM, hyaline. Chlamydospores absent.



Figs 9-11. *Heleococcum alkalinum* (media – alkaline agar): 9 – colony on petri dish; 10 a,b – different stages of ascus development (light microscopy); 11 – thick-walled ascospore: one septate in the middle and not constricted at the septum (light microscopy).

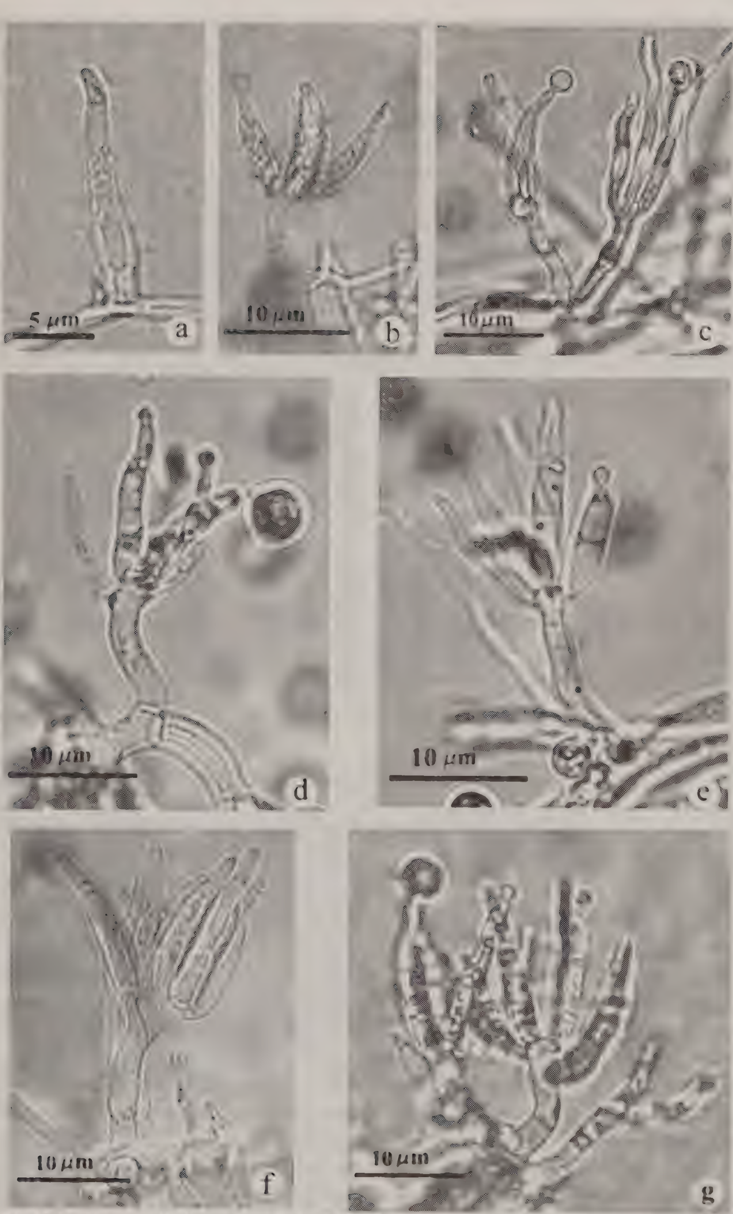

5 µm
a
10 µm
b
10 µm
c
10 µm
d
10 µm
e
10 µm
f
10 µm
g

Fig 12. *Heleococcum alkalinum*: types of conidiophores (F11 on alkaline agar): a – single phialide, b, c – conidiophores with immature conidia, d-g – branched conidiophores

CULTURE GROWTH - The radial growth rate of the three isolates of *H. alkalinum* (F7, F10, F11) was almost equal within the range of pH 6.7-10.8, demonstrating their alkali-tolerant phenotype (Fig. 13).

> **REPRESENTATIVE SPECIMENS EXAMINED** — Strain F 11 from soda soil of north-eastern **MONGOLIA** (pH 10.5; NaCl 4.9%), VIII. 1999, **HOLOTYPE,** deposited in the Herbarium of Centraalbureau voor Schimmelcultures (CBS 110278, also living culture), Utrecht, Holland, and in All-Union Collection of Microorganisms – Fungi (*VKM-F 3762*), Moscow, RUSSIA. **ISOTYPES** – F7, F9 from saline soda soils of Kunkur steppe, South Siberia (Chita region), **RUSSIA**. F10 - **KENYA, AFRICA**. F13, F18 - Kulunda steppe of Altai region, RUSSIA – deposited in the Collection of Fungi, Dept. Mycology, Moscow State University, RUSSIA.

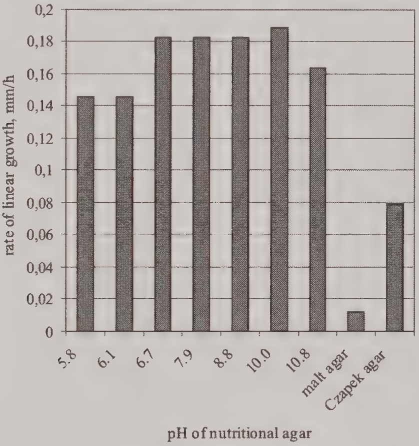


Fig. 13. Radial growth rates of three isolates of *H. alkalinum* depending on pH of the medium

COMMENTS — The genus *Heleococcum* was described by C.A. Jørgensen in 1922 with *H. aurantiacum* as a type species. This species was isolated from moist soil of the Botanical Garden of the University of Copenhagen and was characterized by non-ostiolate, translucent areolated ascomata, globose asci and large orange-colored 2-celled ascospores. No anamorph was observed. *H. aurantiacum* did not produce ascomata in culture. It was placed in the Aspergillaceae. A second collection of *H. aurantiacum* was made by Dennis from mushroom compost in England in 1960. A second species, *H. japonense* Tubaki, was isolated by Tubaki in 1966 in Hokkaido, Japan. This species was isolated from a wood panel of *Abies firma,* submerged in seawater for a long time. The species differed from *H. aurantiacum* by having smaller ascospores and a *Trichothecium*- or *Acremonium*-like anamorph. *H. japonense* developed cleistothecia on malt agar and on seawater agar. Tubaki was the first to review the genus *Heleococcum* (Tubaki, 1967). He suggested that this cleistothecial fungus represents a link between the orders *Eurotiales* and *Hypocreales*. Cleistothecial ascomata, lack of a nectrioid centrum, and

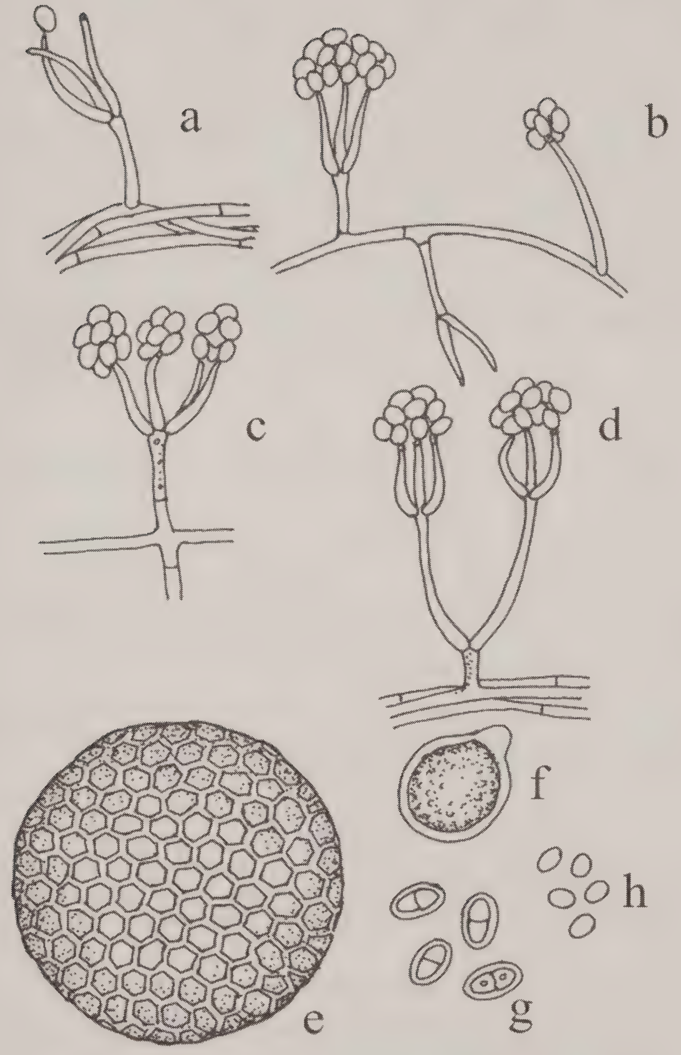


Fig 14. *Heleococcum alkalinum*: a-d – *Acremonium*-like anamorph, e – ascocarp, f – immature ascus, g – ascospores, h – conidia (bar - 10μm).

deliquescent asci are not typical of the *Hypocreales*, but bright-colored ascomata, one-septate hyaline ascospores, *Acremonium-* or *Trichothecium*-like anamorphs suggest that this organism belongs to the *Hypocreales*. Later Rehner and Samuels (1995), using 18S rDNA sequence data, demonstrated that *H. japonense* is hypocrealean and must be placed in the *Bionectriaceae* (Rossman et al., 1999).

Two more species, *H. alatosporum* and *H. inapertum,* described by Udagawa et al. (1995), have been isolated from soils in Indonesia and the Philippines. They had *Acremonium*-like anamorphs. *H. alatosporum* produced salmon-colored ascomata, cylindrical asci, 2-celled small hyaline ascospores with verruculose walls, ornamented with longitudinal ridges. *H. inapertum* was characterized by yellow ascomata, clavate asci and pale yellow ascospores, constricted at the septum, verrucose to weakly striate, surrounded by a hyaline sheath. Udagawa et al. (1995) provided a key to the species of *Heleococcum*, which is based mainly on ascospore size and ornamentation. The list includes:

H. aurantiacum: ascospores 22.5-25.5 × 9-10.5 µm, with an irregular gelatinous sheath;

H. japonense: 18-21 × 10-13 µm, smooth or slightly roughened;

H. inapertum: 10-11 × 5-6 µm, slightly verrucose to striate, surrounded by a sheath;

H. alatosporum: 6-8 × 3-3.5 µm, slightly verrucose, with 2-3 longitudinal, wing-like ridges.

H. alkalinum differs from the all known species of the genus *Heleococcum*, producing dark brown ascomata, pale brown, smooth ascospores, not constricted at the septum, 12-15 x 5-7 µm, the presence of an anamorph of ***Acremonium*** sect. ***Nectrioidea*** type and by its strong halo-alkali tolerance (Fig. 14).

Since all the soda soil isolates of *H. alkalinum* produced an extracellular endocellulase, active within the pH range of 7-11 (unpublished data), it might be speculated that this fungus plays a role in a decomposition of plant biomass in soda soils.

Acknowledgements

The authors are grateful to W. Gams and L. Vasilyeva for prereviewing the paper and to Brian Jones for providing samples from Kenya and V. Volkova for her aid in preparing the halftone photographic plates. This work was partly supported by the Program for Molecular and Cell Biology RAS.

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Tubaki K. 1967. An undescribed species of *Heleococcum* from Japan. Trans. Mycol. Soc. Japan **8**: 5-10.

Udagawa S, Uchiyama S, Kamiya S. 1995. Two new species of *Heleococcum* with *Acremonium* anamorphs. Mycoscience **36:** 37-43.

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MYCOTAXON

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Book reviews and notices

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General

La Enciclopedia de las Setas. By Gerrit J. Keizer. 2004 ["2005"]. Editorial LIBSA, Calle San Rafael 4, Alcobendas, Madrid 28108, Spain. Pp. 286, col. photos 790. ISBN 84 662 1030 X. Price: € 14.90.

This is a Spanish translation of Keizer (1997), prepared by Macarena Rojo. The sheer number of coloured photographs is impressive, and in general their quality is very good. Further, there are 20 pages at the start explaining the diversity of fungi illustrated by coloured phorographs of microscopic features, introducing key biological concepts such as saprophytism and parasitism, and further applications such as the use of lichens as bioindicators, the beneficial effects of fungi on human health, and effects of poisonous and hallucinogenic species. I was especially pleased to see substantial sections on myxomycetes (5 pp.) and larger ascomycetes (50 pp.) placed before the start of the basidiomycetes.

Species descriptions are necessarily brief and concentrate on macrosocopic features, there are notes on habitats and seasonality, and symbols are added to indicate whether species are edible or poisonous. With relatively few exceptions, only scientific names are given, and these are generally up-to-date although some changes have not been followed (e.g. *Coprinopsis*) . There is also a comprehensive index.

Although the date is clearly given as "2005" in the book itself, I purchased this copy in a market in Logrono, Rioja, on 31 October 2004 so it was clearly effectively published in 2004. The author's name is incorrectly given as "Keiser" three times on the dust jacket which I am sure will irritate! Nevertheless, these minor slips hardly detract from the value of the book as a broad-based field guide and introduction to mycology for the numerous amateur field mycologists in Spain.

Keizer, G. J. (1997) *Paddestoellen Encyclopedie*. Lisse: Rebo Productions. [Not seen.]

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[1] Books for consideration for coverage in this column should be mailed to the Book Review Editor (address above) in the first instance. Fax (+34) 91 857 3640; e-mail: myconova@terra.es.

Basidiomycetes

Die Brandpilze Österreichs. *Doassansiales, Entorrhizales, Entylomatales, Georgefischeriales, Microbotryales, Tilletiales, Urocystales, Ustilaginales.*

By Peter Zwetko & Paul Blanz. 2004. Verlag der Österreichischen Akademie der Wissenschaften, Wien, Austria. [Catalogus Florae Austriae Vol. 3(3); Biosystematics and Ecology Series 21.] Pp. iv + 241, maps 27, tables 1, CD 1. ISBN 3 7001 3266 2. Price: € 38.50.

This new number of the *Catalogus Florae Austriae* provides an annotated checklist of the known smut fungi in Austria. Altogether 167 species in 25 genera have been recognized in the country so far. In the catalogue, based on detailed investigations of the available literature sources and specimens, the following genera are considered: *Anthracoidea* (41 species of which 26 are already known, while the occurrence of the rest is treated as possible beacause of host(s) present in the country), *Bauerago* (2/0), *Doassansia* (6/0), *Doassansiopsis* (2/0), *Doassinga* (1/0), *Entorrhiza* (5/2), *Entyloma* (56/23), *Farysia* (2/1), *Glomosporium* (1/1), *Heterodoassansia* (3/0), *Jamesdicksonia* (2/1), *Melanopsichium* (1/1), *Melanotaenium* (6/2), *Melanustilospora* (1/1), *Microbotryum* (37+1/27+1), *Moesziomyces* (1/1), *Moreaua* (2/0), *Nannfeldtiomyces* (2/0), *Neovossia* (1/1), *Orphanomyces* (3/0), *Rhamphospora* (1/1), *Schizonella* (4/3), *Sphacelotheca* (1/1), *Sporisorium* (7/7), *Stegocintractia* (2/2), *Thecaphora* (10/5), *Tilletia* (20/8), *Tolyposporium* (1/0), *Tothiella* (1/1), *Tracya* (2/0), *Tranzscheliella* (3/1), *Urocystis* (71/33), *Ustanciosporium* (3/2), *Ustilago* (25+2/11+1), *Ustilentyloma* (3/0), and *Vankya* (3/3). The genera are presented in accordance with the system of Vánky (2002), except for the genus *Melanustilospora* which was described later, in 2003.

The distribution and ecology of the members of the genus *Anthracoidea,* the best documented genus in Austria, are discussed in detail. The distribution of 29 species is presented on 23 grid maps in colour. In addition, grid maps for 166 species, photographs, and checklists of smut fungi from the various administrative and ecological regions of Austria are given on a CD published together with the book.

A host-fungus index, list of synonyms, and register of fungus names are also provided.

The catalogue has been compiled very carefully, and will be helpful for everyone interested in learning about Austrian smut fungi.

Vánky, K. (2002) *Illustrated Genera of Smut Fungi.* 2nd edn. St Paul, MN: American Phytopathological Society Press.

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Impact of the Family *Agaricaceae* (Fr.) Cohn on Nutrition and Medicine.

By Maryna Didukh, Solomon P. Wasser & Eviatar Nevo. 2004. A. R. G. Ganter Verlag Kommandit Gesellschaft, Ruggell. [Distributed by Koeltz Scientific Books, Herrwalstraße 6, D-61462 Königstein, Germany.] [Biodiversity of Cyanoprokaryotes, Algae and Fungi of Israel No. 5.] Pp. 205, figs 22 (some in colour). ISBN 3 906166 19 8. Price: € 68.

Solomon Wasser has previously published a book in this series on *Agaricaceae* tribe

Agariceae in Israel (Wasser 2002; see *Mycotaxon* **83**: 507-508, July-September 2002). This new book is, however, not a taxonomic revision but rather a detailed review of the nutritional and more especially the medicinal applications of members of the family. Work undertaken is discussed with respect to the original papers in the medical literature and references into 2004 are cited.

The reason for including it in this column is that the book includes a critical discussion of the application of the name *Agaricus blazei,* which proved to be misapplied, and the introduction of the name *A. brasiliensis* for the species now widely cultivated for its medicinal properties. Original diagnoses, and drawings and photographs from the type materials are included, and the separation of *A. brasiliensis* from *A. subrufescens* is also addressed. Spore measurements and other micromorphological and other features from type and other individual collections are presented in a series of tables. A key to *A. brasiliensis* and three allied species is included. The change of name for the mushroom that had been called *A. blazei* was unfortunate, and other nomenclatural options might have been explored further to avoid this. Whatever position a mycologist takes on this hotly debated and controversial issue, this new book is the place to consult for the crtitical taxonomic investigations which led to the name change.

Wasser, S. P. (2002) *Family Agaricaeae (Fr.) Cohn of Israel Mycobiota I. Tribe Agariceae Pat.* Ruggell: A. R. G. Ganter Verlag Kommandit Gesellschaft.

Ustilaginales. By Milda Ignatavičiūtė. 2001. UAB "Valstiečių Laikraštis", Laisvės pr. 60, 2056 Vilnius, Lithuania. [Mycota Lithuaniae, Vol. 4.] Pp. 199, figs 82. ISBN 9986-847-44-3. Price: Not indicated.

The smut fungi of Lithuania are represented in this book by 117 species in 13 genera: *Anthracoidea* (21 species), *Doassansia* (2), *Entyloma* (14), *Farysia* (1), *Glomosporium* (1), *Schizonella* (1), *Sphacelotheca* (1), *Sporisorium* (5), *Thecaphora* (2), *Tilletia* (2), *Tolyposporium* (1), *Urocystis* (20), and *Ustilago* (46). Two introductory chapters provide brief information on the history of investigations of the smut fungi in Lithuania and on the morphology and systematics of that group of fungi. The main body of the book consists of descriptions, illustrations, and keys to genera and species. The text is in Lithuanian, but summaries in English (6 pp.) and Russian (5 pp.) are added. A list of the Lithuanian names of the known smut fungi, fungus-host index, and registers of fungus and host names are also provided.

Unfortunately, most literature sources cited were published before 1990, and evidently used in the species treatments. It is strange that even the European monograph of smut fungi by Vánky (1994) and his revision of *Microbotryum* (Vánky 1998) were not considered. In conseqeunce, some generally unaccepted species are recognized here, for example *Sorosporium purpureum, Ustilago agrostis-palustris, U. airae-caespitosae, U. alopecurivora, U. anthoxanthi, U. brizae, U. bromina, U. coronariae, U. carnea, U. festucarum, U. muricata, U. perennans, U. persicariae, U. poarum,* and *U. salweyi* (as "*salveii*"). The genera are presented in accordance with the classical scheme of one order and two families, *Ustilaginaceae* and *Tilletiaceae*, despite the system of the smut fungi having changed radically in the 1990s. The monograph is consquently mainly of value for the information presented on morphometrical variability, and both species distribution and host ranges within Lithuania.

Vánky, K. (1994) *European Smut Fungi*. Stuttgart: Gustav Fischer Verlag.
Vánky, K. (1998) The genus *Microbotryum* (smut fungi). *Mycotaxon* **67**: 33-60.

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Distribution Maps of Estonian Fungi [Eesti Seente Levikauatlas]. Vol. 3. Pore Fungi [Torikseened]. By Erast Parmasto. 2004. Institute of Ecology and Botany, Estonian Agricultural University, Tartu, Estonia. [Scripta Mycologica No. 19.] Pp. 222, maps 215. ISBN 9985 50 380 5. Price: Not indicated.

This third volume of maps of Estonian fungi deals with 211 species of polypores. Most of the maps are new, but some are updates of ones which first appeared in one of the earlier volumes, issued in 1993 and 1999. The maps are based on more than 6500 reference specimens and about 7000 field observations made on these fungi in the country, mainly by the author. For each species, the scientific name with author citation and place of publication, Estonian name, and Estonian Red Data Book status are provided; any legal protection category that applies is also indicated. Information is also provided on the distribution, habitats, hosts, and seasonality, along with comments on the effects of human impact or their importance as tree pathogens. In cases where there are less than ten records, full specimen and locality information is included. Exsiccati and literature are cited where appropriate. The text for each species is given first in English followed by a synopsis in Estonian. Two maps are presented in each case, a small one based on the 50 × 50 km UTM grid, and a larger one on the 10 × 10 km UTM grid. On the larger maps, I was very pleased to see different symbols used to indicate whether the records were based on herbarium specimens checked by the author, published reports, specimens "observed but not collected by mycologists", or now extinct; such a use of symbols is something I would like to see adopted more widely. A work meticulously executed to the highest of standards, but what else would one expect from Erast?

Ascomycetes

Le Specie Europee del Genere *Tuber*: Una revisione storica. By Arturo Ceruti, Anna Fontana & Carolina Nosenzo. 2003. Museo Regionale di Scienze Naturali, Torino, Italy. Pp. 466, 45 col. plates. ISBN 88-86041-54-3. Price: € 40.

The subtitle "A historical revision" aptly describes this detailed treatment of the European species of *Tuber.* It brings together the early literature on truffles, pre-Linnaean to the present, not just citations but also the original descriptions of the genus and its European species quoted in full, starting with Micheli in 1729. This long history is both a blessing and a curse to modern taxonomists: a blessing, because so much has been written about the genus and so many collections are available for study, a curse because of the early confusion about species concepts, descriptions so brief as to be useless, and lack of type collections for most taxa described before the 20th century. Some of the confusion persists to the present, although application of the *Code*'s rules for typification, carefully applied along with morphological and molecular evidence, should eventually clarify most of the murk.

Electronic library services simplify the work of today's taxonomist, but many relevant papers of the 18th and 19th centuries are nonetheless difficult to track down. Moreover, libraries can be reluctant to photocopy or scan old literature, because the handling can damage pages rendered fragile from age. By compiling nearly all the original protologues of European *Tuber* species in their original languages in one volume, the authors magnificently serve all taxonomists who will deal with the genus from now on. The plates at the end of the book include superb reproductions of many of the beautiful, old paintings of truffle species once a feature of now rare taxonomic treatments. In addition to taxonomy, notes on the distribution, habitat and ecology of each species are included, followed by an extensive and, I would judge, nearly complete bibliography on its taxonomy and ecology. Thus the book has value to researchers on truffle biology and production as well as taxonomists.

Aside from the original species descriptions, the text is in Italian. However, anyone familiar with a romance language or English and has an Italian dictionary on hand can understand the straightforward wording with relatively little difficulty, especially because the mycological terms are essentially universal.

The authors acknowledge the difficulties presented by the taxonomic confusion and resulting nomenclatural morass left in the wake of early workers. The book would have been an appropriate outlet to establish order out of that chaos or at least provide a detailed nomenclatural chronology as a basis for applying the *Code* to establish correct names. This forbidding task was evaded by the authors, who elected generally to accept names coined by Vittadini in 1831 in lieu of those earlier sanctioned by Fries. This approach has a certain logic, because Vittadini's names, not Fries', have held sway since 1831 in the common, economic and scientific parlance of truffles. However, the *Code* is the standard that scientists use, and it needs to be at least acknowledged in a book such as this. The long-term solution would be a proposal to conserve the Vittadini names under the *Code*, but the authors do not suggest this.

In listing synonyms of the species they accept, the authors have indeed produced "a historical revision:" their conclusions are based for the most part on the often inadequate literature rather than a study of type collections. I can state this dogmatically, because North American species are erroneously synonymized under European names. This could never have happened if type collections had been examined. For example, *Tuber gibbosum* is given as a synonym of *T. foetidum*, but the two species differ strikingly in several morphological characters, not to mention that *T. gibbosum* occurs only in mycorrhizal association with *Pseudotsuga menziesii*. The western North American *T. gardneri* is noted as a synonym of the German *T. murinum*, which in turn is listed as a synonym of *T. puberulum*. However, the surface of the latter is cloaked in long, tapered cystidia, which are absent on the first two. Rather than belabour the point further, I suggest this book not be taken as the final word on synonymies for species of *Tuber*. However, it does provide the original sources and descriptions for the taxa listed as synonyms, so it still serves that useful purpose.

This volume is hardbound and composed of high quality paper. Despite its shortcomings, it provides so many services as to be obligatory for the bookshelves of all mycologists interested in the genus *Tuber*. Moreover, it exemplifies how mycology could be well served by similar compendia for other groups of fungi.

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Revised Synopsis of the *Hyaloscyphaceae*. By Ain Raitviir. 2004. Institute of Ecology and Botany, Estonian Agricultural University, Tartu, Estonia. [Scripta Mycologica No. 20.] Pp. 132, figs 55. ISBN 9985 9293 3 0. Price: Not indicated.

Raitviir's original synopsis of this family of 1970 was something of a wake-up call to a rather complacent community of discomycetologists. Suddenly, generic concepts had changed and there were new names to learn. Many were slow to follow, but as the characters and concepts Raitviir employed came to be more widely examined and understood, respectively, he soon became recognized as the world's leading authority on these fungi. Some 34 years on, those expecting this title to cover the same spectrum as the 1970 one are in for another jolt. This volume covers the *Hyaloscyphaceae* as the author now interprets it – as a family separate from the *Lachnaceae* (which is raised to family status here for the first time). This decision is supported by a series of molecular studies but has not previously been translated into a new formalized taxonomic scheme. Thus, if you hoped to see a revision of the much debated generic concepts around *Lachnum,* and treatments of the huge numbers of species therein, these are not to be found here but are planned to be treated in a future volume (along with the *Arachnopezizeae*).

However, despite the removal of the *Lachnaceae,* 29 genera and 241 infrageneric taxa are treated here. Following a key, the genera are arranged alphabetically, with keys to accepted species, detailed accounts of the individual species, and notes on any excluded species. In many cases, clear line drawings of excipular hairs, asci, paraphyses, and ascospores are provided. The largest genera accepted are *Cistella* (40 spp.), *Hyaloscypha* (21), *Mollisina* (12) and *Urceolella* (23), and three genera are newly described: *Chimeeroscypha* (type *Hyalopeziza echinulata*), *Gemmina* (type *Hymenoscyphus gemmanum*) and *Remleia* (type *Calycellina myrtillinoides*). Six species are described as new for science, and 28 new combinations and one new name are introduced.

The results are likely to take some time to be fully digested and accepted, especially when there is little molecular information on many of these fungi, but in any event this is destined to be recognized as one of the essential references on inoperculate non-lichenized discomycetes which all mycologists specializing in these fungi will need to have to hand.

Lichen-forming fungi

Lichens 4. Edited by Patrick M. McCarthy & Katy Mallett. April 2004. CSIRO Publishing, 150 Oxford Street, P. O. Box 1139, Collingwood, VIC 3066, Australia. Pp. xvi + 222, figs 3, col. pl. 56, maps 287. [Flora of Australia Vol. 56A.] ISBN 0 643 09056 8 (hardback), 0 643 09057 6 (paperback). Price: AU $ 95 (hardback), AU $ 80 (paperback).

As announced in *Lichens 3* (see *Mycotaxon* **83**: 505-506, 2002), the policy of publishing accounts as they are completed rather than having volumes devoted to particular orders or families is continued here. This volume treats 17 genera and 287 specific and infraspecific taxa, bringing the number of species treated in the four volumes to 1168, just over one third of the species known from the country. This volume has contributions from A. A. Archer, J. A. Elix, G. Kantvilas, H. T. Lumbsch, P. M. McCarthy, and G.

N. Stevens, and covers the following families and genera: *Aphanopsidaceae* (*Steinia,* 2 spp.), *Fuscideaceae* (*Fuscidea,* 8; *Hueidea,* 1; *Maronea,* 1; *Orphniospora,* 1; and *Ropalospora,* 1), *Haematommataceae* (*Haematomma,* 11), *Lecanoraceae* (*Lecanora,* 73; *Maronina,* 1; and *Ramboldia,*7), *Miltideaceae* (*Miltidea,* 1), *Pertusaricaeae* (*Pertusaria,* 119), *Roccellinastraceae* (*Roccellinastrum,* 3), *Sarrameaceae* (*Loxospora,* 1; and *Sarrameana,* 2), and *Usneaceae* (*Neuropogon,* 2; and *Usnea,* 37). The style follows that of previous volumes, and the accounts are meticulously produced to the highest academic standards. The colour photographs are superb, especially the close-up shots of *Lecanora* fruits which will be of major assistance in making identifications; again, the project has been fortunate in securing the photographic skills of William M. Malcolm. Many of the maps show distinctive distribution patterns, clearly not just chance collecting, which is especially pleasing to see for crustose species in particular; unfortunately five maps on p. 195 are wrongly numbered; maps 111-115 on that page should be relabelled 101-105. As this volume covers three particularly large genera, *Lecanora, Pertusaria,* and *Usnea,* it will be a "must have" for all working on Australasian and Southern Hemisphere lichens. My one regret is that no action has yet been taken to at least give the lichen volumes double-numbering in the companion *Fungi of Australia* series; to continue to perpetuate the idea that lichens are something other than a fungal life-style contradicts the aim of the series to present an up-to-date view of lichen-fungi in the country.

Velgids Korstmossen. By Kok van Herk & André Aptroot. 2004. KNNV Uitgeverij, Oudegracht 237, Postbus 19320, 3501 DH Utrecht, The Netherlands. Pp. 424, numerous col. pl. [2nd edn.] [Velgids No. 19.] ISBN 90 5011 175 0. Price: € 33.95.

This is so much expanded and improved from the first edition, published a decade earlier (Aptroot & van Herk 1994), that it is hardly recognizable as such; perhaps that is why this fact is not mentioned on the reverse of the title page! Following a short introduction to lichen characters, biology and ecology, including comments on the effects of climate change, information on around 400 species is presented. The genera and species are arranged alphabetically, and while generic diagnoses are omitted, the detail given for each species more than compensates: Dutch names, characteristics, reagent tests, notes on the separation from taxa with which the species might be confused, ecological information, and comments on the distribution in The Netherlands (in many cases with dot maps). Two or three species are treated on each double-page spread, with the text opposite outstanding colour photographs. By the side of each picture there is an ingenious rainbow scale device indicating rarity by the number of grid squares the species occurs in and (except for some mainly recently recognized species) an arrow directed to show whether the species is increasing, decreasing, or stable. One or more further symbols indicate at a glance whether the species occurs on wood, bark, rocks and walls, or the ground.

It is especially pleasing to see numerous crustose lichens included, amongst which are several recently described by the authors and others, for which colour photographs have not previously been published, for example *Bacidia adastra, B. neosquamulosa, Lecanora sinuosa, Macentina stigonemoides, Micarea virideleprosa* and *Pyrenocollema chlorococcum.* These pictures are sure to facilitate recognition of some of these species elsewhere in Europe as well as in The Netherlands. With such a coverage of crustose species, I was surprised that microscopic details on such features as spore sizes were omitted from the descriptions. Apart from a table to help separate brown parmelioid species, there is no key or synoptic arrangement of genera by orders and families. The intention is evidently that users rely on the photographs, macroscopic features, and reagent tests to make identifications. The quality of colour reproduction is therefore critical, and while in most cases the colours are true to nature, in some they might mislead; for instance the *Bryoria fuscescens* appears almost orange, the *Xanthoria candelaria* pale green, and the *X. calcicola* and *X. parietina* are somewhat anaemic.

The nomenclature and taxonomy are generally sound and up-to-date, but I certainly did not expect still to be seeing *Cladina* accepted as distinct from *Cladonia*. The book ends with a glossary, separate indices to Dutch and scientific names, a summary of recent name changes, and a short literature list.

This fine book will be a major boost to lichen recording in The Netherlands, and a particular boon to field lichenologists elsewhere with irritating sterile leprose crusts to name.

Aptroot, A. & van Herk, K. (1994) *Velgids Korstmossen.* [Velgids No. 7.] Utrecht: KNNV Uitgeverij.

Guía de Campo de los Líquenes, Musgos y Hepáticas. By Volkmar Wirth, Ruprecht Düll, Xavier Llimona, Rosa María Rosa & Olaf Werner. 24 April 2004. Ediciones Omega, Calle Plató 26, ES-08006 Barcelona, Spain. Pp. 590, numerous col. pl. ISBN 84 282 1266 X. Price: € 59.

Wirth's (1995) two volume work on the lichens of Baden-Württembergs is generally recognized as one of the most superbly illustrated books on lichens available, but its cost and that it is in German restrict its use. Further, and naturally, it did not treat species absent from that part of Germany. A subsequent guide to the lichens and bryophytes of central Europe, including 133 lichens and 101 bryophytes, was prepared by Wirth & Düll (2000). In this new guide many of Wirth's lichen photographs are supplemented by additional ones, mainly taken by Xavier Llimona, and a new Spanish text. The number of lichens treated is more than doubled to 288, but this is still a rather modest proportion of the 2426+ species known from the Iberian Peninsula. However, the species included have clearly been carefully selected and include many crustose species. Amongst these are many lichens locally frequent in the Mediterranean region but unknown or rare elsewhere and which are consequently absent from or not illustrated in other European field guides. Examples are *Buellia almeriensis, Cetraria crespoae, Coscinocladium gaditanum*, *Diploschistes ocellatus, Dirina ceratoniae, Epiphloea terrana, Lasallia hispanica, Lepraria isidiata* (syn. *L. crassissima* var. *isidiata*) comb. nov., *Pertusaria pluripuncta, Protoparmelia psarophana,* and *Rhizocarpon epispilum*. Each species occupies a whole page, the upper part with a single or two photographs, and the lower part with information on key characters, reagent tests, species with which it might be confused, and notes on ecology and distribution.

The lichens are arranged in 20 artificial groups, mainly on the basis of macroscopic features of the thallus and fruit bodies. While these are keyed out, this means repeatedly using the index to locate the treatments of species. I would have preferred an alphabetical arrangement, especially as under the scheme used species of the same genus are frequently separated into different groups (e.g. *Acarospora, Buellia, Lecanora*). A systematic outline is, however, provided. The taxonomy used is cautiously conservative, accepting some recently adopted genera but wisely not others. Identifications are generally authoritative, although the photograph of *Punctelia subrudecta* (as *Parmelia subrudecta*) is actually of *P. ulophylla* (with marginal soralia). The colour reproduction is of the highest standard and almost without exception true-to-life, although I was sad to see the naturally striking deep orange underside of *Solorina crocea* so pale (perhaps a result of the use of flash).

I do, however, find it irritating that in the 21st century we have a text that also covers bryophytes! Not only does this perpetuate the obsolete idea that lichens might be allied to bryophytes to the general naturalist, it means that by omitting them a further 226 lichens could have been covered in the book. I do hope this possibility will be considered for any future edition.

This superbly produced work is destined to be the one all lichenologists working in the Meditteranean region carry on their excursions, and was already very much in evidence in many pockets and bags during the excursion of the Sociedad Española de Liquenologíca in the Rioja area in September 2004.

Wirth, V. (1995) *Die Flechten Baden-Württembergs*. 2 vols. Stuttgart: Verlag Eugen Ulmer.
Wirth, V. & Düll, R. (2000) *Farbatlas Flechten und Moose*. Stuttgart: Verlag Eugen Ulmer.

Líquenes de Costa Rica: Lichens. By Loengrin Umaña & Harrie [J. M.] Sipman. 2002. Instituto Nacional de Biodiversidad, Apdo. Postal 22-3100 Santo Domingo de Heredia, Costa Rica. Pp. 156. ISBN 968 702 74 9. Price: US $ 9.

Coping with tropical lichens is a major shock for lichenologists weaned on temperate species. This primer, with texts in both Spanish and English, could be their saviour when visiting Central or South America for the first time. While only 55 species are treated, these are a mixture of macro- and microlichens. Each entry is accompanied by a generally good quality coloured photograph (or in some cases more than one to show details). Notes on habitat and distributions in the country and worldwide are added, and additional comments are provided in some cases. The species are arrranged by habit; an alphabetical ordering would, however, have been preferrable, especially for users unfamiliar with categories such as 'Fruticose dimorphic with short podetia'. A glossary is provided and there is also a helpful list of internet sites, including one to a checklist of the lichens of Costa Rica maintained at The Field Museum of Natural History in Chicago (www.fmnh.org/research collections/botany/ botany sites/ticolichen/checklist.html). Those interested in Central and South American lichens should endeavour to secure a copy while stocks last. This may not be so easy: I eventually obtained a copy *via* a close colleague who was a personal friend of the first author as my earlier direct approaches to the publishers had failed to elicit any response.

Biodiversity Documentation for Kerala. Part 3: Lichens. Compiled by P. S. Easa. 2003. Kerala Forest Research Institute, Peechi 680 653, Kerala, India. [KFRI Handbook No. 17.] Pp. 61. ISBN 81 85041 44 X. Price: US $ 15.

Although there have been numerous papers on Indian lichens published over the last 20-30 years, there are rather few regional syntheses, yet such compilations are critical to make the link between the primary literature and fieldworkers. This work reveals that 429 species of lichen-forming fungi have been reported from Kerala, 248 of which are macrolichens. The species are grouped into micro- and macrolichen categories and then arranged alphabetically by family. For 299 species, information on habitat, distribution, and the source of the record is provided. This figure is 130 species less than the total as that number of records of unlocalised microlichens occurs in one 1999 paper, the names just being presented as a table. There is a short introduction, but not one drawing attention to where descriptions and keys can be found to the treated species; this would have been a helpful addition for non-specialists. Perhaps a future edition could include keys and illustrations to make the contents even more accessible.

The Lichen Hunters. By Oliver [L.] Gilbert. 2004. The Book Guild, 25 High Street, Lewes, East Sussex BN7 2LU, UK. Pp. ix + 208, coloured photographs 19. ISBN 1 85776 930 9. Price: £ 16.95.

Essentially a lichenological autobiography by one of the UK's most energetic and astute fieldworkers. Full of snap-shots of special moments while out collecting, and reminiscences quoted from colleagues, this is a delightful social commentary on field lichenology in the UK from the mid-1960s and the personalities involved who the author chanced to meet and enjoyed excursions with. But is not without inaccuracies when reporting events where the author was not a party and which were received second-hand. Further, I would have liked to see more prominence given to the work of others, especially Humphrey Bowen (only mentioned on p. 22), Mark Seaward (hardly mentioned after p. 26), and Jack Laundon (not cited after p. 49). Even Francis Rose, surely the foremost UK field lichenologist and ecologist of the 20th century, is not mentioned between pages 29 and 178, nor is the epic tour Francis made with Brian Coppins and myself around the north of England in 1969 that led to the scale relating lichen communities to mean winter sulphur dioxide levels published in *Nature* the following year (even though Oliver Gilbert was involved in part of that excursion). Perhaps understandingly somewhat self-effacingly, he hardly does justice to his own pioneering work on lichens and air pollution in the Newcastle upon Tyne area that started in the mid-1960s. But to state that such scales "have not stood the test of time" (p. 17) is misleading, unhelpful, and denigrates the importance of Gilbert's own work; it is true that simplistic applications can be misleading when sulphur dioxide levels have fallen and other pollutants have risen in importance, but in 35 years no signficant exceptions to the tolerance limits then estimated by Gilbert and others have been found, and the principles he pioneered still apply perfectly in parts of the world where sulphur dioxide is the main air pollutant!

This is far from the definitive history of the period, something that will need to be prepared later and objectively by someone other than one of its players, but a good bed-time read with many insights into the enthusiasm and drive of field lichenologists willing to camp, trek, and collect under often harsh conditions to make new finds. The book may well inspire some newcomers to the field, and others may reflect on the social aspects, both the comraderie and dedication of such frenetic and enthusiastic lichen hunters. Outside lichenologists, it will certainly be a "must" for those interested in the sociological aspects of natural history exploration in general.

Conidial fungi

***Penicillium* subgenus *Penicillium*: New taxonomic schemes, mycotoxins and other extrolites.** By Robert A. Samson & Jens C. Frisvad. 2004. Centraalbureau voor Schimmelcultures, P. O. Box 85167, 3508 AD Utrecht, The Netherlands. [Studies in Mycology No. 49.] Pp. vi + 258. ISBN 90 70351 53 6. Price: € 50.

This number of *Studies in Mycology* comprises four contributions on the economically most important subgenus of *Penicillium.* The most substantive of these (173 pp.) is a predictive polyphasic taxonomy prepared by Frisvad & Samson. This and correct identifications are paramount as these are amongst the most difficult of fungi to identify accurately. Nevertheless, this new presentation is intended to be stable for many years. The paper definitely has an extrolite emphasis. 'Extrolite' is the term coined by Frisvad for externally produced compounds that previously were generally referred to as secondary metabolites, although the term does not appear to cover secondary metabolites which function internally (such as those associated with conidiation). I no doubt approached this paper with an idiolite bias.

In all 58 species are accepted, of which four are new, and some terverticillate species are intentionally excluded. Phenotypic characters used include micro- and macromorphology, physiology, and nutritional characters. All species were analysed for secondary metabolites, and the profiles were highly species-specific and "often" of high consistency. The history of the use of secondary metabolites in penicillia is discussed. Cultures were all analysed by HPLC DAD and electrospray mass spectroscopy – not facilities to be found in a typical taxonomic laboratory (unfortunately). It is noted that nucleic acid characters were not included, which is surprising in the current climate and for such a well-studied genus. Descriptions, excellent colour illustrations of colonies, and almost 3D micromorphology images of all the treated species are provided. Keys to the taxa are included and a database with further details is provided at http://www.cbs.knaw.nl/penicillium.htm. The authors confirm that identifications are difficult because the micromorphologies are all very similar. However, a synoptic key is provided for the 17 series despite this assertion. It would be interesting to express the data provided in the "box" keys, and the other information in a dendrogram.

I produced a dendrogram myself from the extrolite information presented which I entered into a database for use in ongoing (including DNA) studies on penicillia in my laboratory. Species emerged as usually distinct, however, *P. dipodomyicola, P. formosanum* and *P. ulaiense* clustered more on a lack of production than the reverse (all from sect. *Penicillium*). *P. dipodomyis, P. nalgiovense,* and *P. flavigenum* were closely related and all from series *Chrysogenum. P. commune* and *P. camemberti* were very similar and both belong to series *Camemberti.* Equally, *P. echinulatum* and *P. solitum* were virtually the same and both from series *Solitum.* There was a large cluster from species numbers 21-28 in my dendrogram of a mixed series origins. Another cluster was apparent from numbers 49-52, consisting of sects. *Viridicatum* and *Penicillium.* One group of species (25, 30 and 55) clustered, although otherwise unrelated. This was followed by triplet 15-18, all from series *Viridicata.* A large cluster from species 2-17 were all sect. *Viridicata* apart from one of sect. *Penicillium* (53). Finally, important individual species formed "single member clusters." In summary, there appears to be relatedness in some cases from the extrolite data alone.

The subgenus is characterised by having plastic phenotypes rendering taxonomies very unstable. Other characters are required to stabilise the taxonomy and to recognise new species. Controversially, the authors state that DNA sequencing is more suited for phylogenetic studies and less satisfactory for classification and identification than phenotypic data. Surely that depends on the available technological equipment and expertise – in many laboratories molecular facilities are routinely used by students while there may not even be an obsolete HPLC in the faculty. In fact, very few differences have been found by other workers between taxa in the sequenced ITS1 and ITS 2 regions in this subgenus, for example that of Peterson on its rDNAs. The authors conclude that rDNA has too few differences to reveal the phylogeny of the penicillia (or that they are monophyletic – my addition). However, the second paper in the issue uses partial ß-tubulin gene sequences and gives "a more resolved phylogeny". Although it is revealing that the two ochratoxin A "species" are identical. The difficulty in evaluating some other studies is mentioned, such as those of Bridge *et al.* in the 1980s.

As many isolates of each species "as possible" were examined to determine variability, but without providing the actual numbers studied. It is mentioned that cultures were occasionally not in good condition after years of maintenance in collections of fungal cultures, which sounds somewhat perverse. Many controversies exist about the use of infraspecific ranks, such as variety and subspecies. It is noticeable that all the varieties Frisvad recognized previously have now disappeared.

It is apparent that to obtain species identifications in the Frisvad & Samson scheme, data on all the chemistry, physiology and morphological methodologies is required; one must wonder as to the feasibility of so doing in busy laboratories. Most of the species are associated with the foods/feeds of terrestrial animals, or in some cases their dung (is there a difference?). The authors assert that most are associated with particular habitats, a statement which is somewhat contradicted by saying that most authors regard them as ubiquitous weed organisms!

A third paper in the issue reviews the mycotoxins and pharmaceuticals produced by the subgenus, and suggests that they are still being "bioprospected". The authors' marvel that previous schemes were in any way successful without extrolite characters. However, it is also stated that accurate identifications are possible without extrolites, again something of a contradiction. Frisvad & Samson´s penicillia concepts are closer to those described by Raper & Thom in 1949 than by Pitt in 1980, so there is a sense of coming full-circle. I cannot help thinking that a simpler identification system followed by relevant biochemical analyses would be more helpful (Paterson *et al.* 2004).

The final paper of the quartet is devoted to classification by electrospray mass spectrometry. An extremely elegant and sensitive approach, but unlikely to be able to be applied in all but the most sophisticatedly equipped laboratories.

The English is uneven on occasions throughout (e.g. p. 40), and neither is it free of typographical errors. In addition, my issue disintegrated into loose leaf form upon first opening. Further, I cannot accept that aromas of cultures should ever be used as characters in case toxic or carcinogenic compounds are inhaled. Indeed a section on safety would have been appropriate. Nevertheless, I can think of no other taxonomic workers in the world who could have produced this work, because of its technical sophistication and their combined experience. This publication will be indispensable to a wide range of mycologists because of the inclusion of mycotoxin, pharmaceutical, and ecological information, and constitutes another landmark in the series of key works on penicillia.

Paterson, R. R. M., Venâncio, A. & Lima, N. (2004) Solutions to *Penicillium* taxonomy crucial to mycotoxin research and health. *Research in Microbiology* **155**: 507-513.

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A Monograph of *Fusicladium* s. lat. (*Hyphomycetes*). By Konstanze Schubert, Anja Ritschel & Uwe Braun. 2003. Druckerie der Martin-Luther-Universität Halle-Wittenberg, Kröllwitzer Straße 44, D-06120 Halle/Salle, Germany. [Schlechtendalia No. 9.] Pp. 132, figs 58. ISSN 1436-2317. Price: € 2.5 [free PDF files available for private users].

Critical monographs are the backbone of taxonomy. This one addresses the fungi referred to *Fusicladium* and other genera which have teleomorphs, where known, in the ascomycete genus *Venturia* and its close allies. *Pollaccia* and *Spilocaea* are treated as synonyms of *Fusicladium,* a decision supported by molecular data, and the more familiar generic name has responsibly been proposed for conservation over the earlier *Spilocea* and *Cycloconium* (Braun *et al.* 2002). Other less-familiar genera treated as synonyms are *Basiascum, Fusicladiopsis, Fusicaldiosporium, Hormocladium, Karakulinia, Megacladosporium, Napicladium,* and *Ramalia.* It is concluded that characters such as the arrangement of the conidiophores (solitary, fasciculate or sporodochial), the proliferation of the conidiogenous cells, whether the conidia form singly or in chains, and the shape and size of the conidia are appropriate for the recognition of species but not genera.

In total, 54 species are treated, including four new species, and 11 new combinations. The number of new scientific names would have been higher had the authors not adopted to policy of not introducing separate names for anamorphs where they are strictly confined to and connected with the teleomorph (e.g. "*Fusicladium* state of *Apiosporina collinsii*"). Where the anamorphs do occur separately, however, separate binomial names are given for them. The number of doubtful and uncertain names remaining, mainly because type material could not be located, is 22. In addition, 46 names are excluded, mostly belonging to genera such as *Cladosporium, Passalora,* and *Pseudocercospora.*

Detailed descriptions of the accepted species are provided, along with full details of synonyms, types, line drawings, information on hosts and distribution, and references to previously published illustrations and distributed exsiccati. There is a helpful key to similar genera which deserves to be widely used (p. 10), but I was surprised to see the "index/key" to accepted species. The latter is arranged by host families and genera, with separating characters only given when more than one species occurs on a particular genus. While I appreciate the utility of such keys, it would have been helpful to have a complementary key bsed on the characters of the fungi alone. How else can a *Fusicladium* from an unknown or unidentified host be checked for without painstakingly going through the individual species accounts?

This is certain to be the major reference work on these anamorphs of *Venturiaceae* for decades to come, and at such a modest price (!) there is little excuse for copies not be available in all major plant pathological and mycological libraries.

Braun, U., Ritschel, A. & Schubert, K. (2002) Proposal to conserve the generic name *Fusicladium* against *Spilocaea* (hyphomycetes). *Taxon* **51**: 557.

A Monograph of *Verticillium* Section *Prostrata.* By Rasoul Zare & Walter Gams. 2004. Plant Pests and Diseases Research Institute, P. O. Bix 1454, Tehran 19395, Iran. [Rostaniha Suppl. No. 3.] Pp. v + 188, figs 73, tables 8. ISSN 16084306. Price: US $ 20.

The main results of Zare & Gams's critical rappraisal of the status and relationships of the disparate fungi formerly placed in *Verticillium* sect. *Prostrata* appeared in a series of six papers published in *Nova Hedwigia* over the years 2000-2001, with the key points being summarized by Gams & Zare (2002). This monograph combines the information from the earlier papers into one volume "to make the whole text better accessible" (p. 3). A key to the treated and some similar or related genera is followed by results of molecular phylogenetic studies using ITS, SSU and LSU nuclear rDNA sequences. The major part of the work is devoted to treatments of the independent genera that are recognized by the authors: *Lecanicillium* (17 spp.), *Pochonia* (8), *Haptocillium* (7), *Rotiferophthora* (2), and *Simplicillium* (4). Keys to the species are provided for each genus, and the species accounts include synonyms, descriptions, cultural characteristics, lists of strains examined, line drawings and(or) micro-photographs, and often detailed discussions. Where teleomorphs are known, I was pleased to see descriptions of them also included, sometimes accompanied by illustrations.

The concept of *Lecanicillium* is described as "obviously paraphyletic", and may not be the last word on that subject. Some species also remain to be treated, for example those with catenate conidia, and further *V. epiphytum, V. incurvum* and *V. pseudohemipterigenum* which are treated as a "residual group".

It is excellent to have all this information drawn together in one place, and at a reasonable price, though sadly some of the phylogenetic trees and half-tone photographs have lost much of their original sharpness in reproduction. I must, however, question the title; the inclusion of the main new generic names in the title would, at a glance, have indicated that this was the place to seek a monograph of, for example, *Lecanicillium*. Many of the applied mycologists who will need to use and benefit most from this volume may not be familiar with the taxonomic history of the group and so could easily pass the title by.

Gams, W. & Zare, R. (2002) New generic concepts in *Verticillium* sect. *Prostrata*. *Mycological Research* **106**: 130-131.

Slime-moulds

NOMENMYX: A nomenclatural taxabase of *Myxomycetes*. By C[arlos] Lado [Rodriguez]. December 2001. Consejo Superior de Investigaciones Científicas, Servicio de Publicaciones, Vitruvio 8, Madrid 28006, Spain. [Cuadernos de Trabajo de Flora Micológica Ibérica No. 16.] Pp. 222. ISBN 84 00 07951 5. Price: € 15.63.

This series of publications, prepared by the Real Jardín Botanico de Madrid, is designed to support work on the *Flora Micológica Ibérica* monograph series, the sixth volume of which appeared in 2004 (see *Mycotaxon* **90** (1): 230-231, July-September 2004). Most numbers concern the Spanish literature on different groups of fungi and are therefore mainly of regional importance. NOMENMYX is an exception. It is an outstanding reference work all myxomycete specialists will find of immense value, as it compiles all scientific names used for myxomycetes and indicates their status and appliccation. Almost 4000 names are included, and for each the author(s) and place of publication are provided. The entries are arranged alphabetically by genus and species in two main sections. The first is a "List of accepted" names, with the some 2100 synonyms relating to these listed under the appropriate accepted names; about 900 species are recognized as "accepted". The second list covers about 1000 "Invalid, excluded or doubtful names", and contains ones which are not validly published (placed in inverted commas), and has extensive critical annotations explaining their status. The sources of previously published opinions and references to selected works where names have been used are also given (particularly Martin & Alexopoulos 1969). In order to facilitate the location of treated names, two separate indices are provided, one arranged by genus names and the other by species epithets. There are also appendices on the names of authors and abbreviations employed for them, and of abbreviations of book and journal titles used in the entries. In order to make the work as authoritative as possible, advice from other leading myxomycete specialists has been obtained. Somewhat surprisingly for a catalogue, 44 new combinations are made, mainly transfers into the genera *Hyporhamma* and *Tubulifera*. *Hyporhamma* is taken up as an earlier name for *Hemitrichia,* on the grounds that the latter had not been formally proposed and accepted for conservation, but no susbtantive reason for not retaining the familiar name and in the meantime making the conservation proposal is presented.

Notwithstanding the decision of the 1993 International Botanical Congress not to adopt provisions for protected "Lists of Names in Current Use", the author "thinks that this list also will serve, as a draft or starting point for the development of a list of *Names in Current Use (NCU)* to be employed for *Myxomycetes*, in the manner defined by Greuter . . . " . I concurr, as it is such painstakingly prepared critical lists that have been evaluated by specialists that are necessary to bring the NCU dream closer to reality.

The list was compiled using a database structure developed by Francisco Pando, a fellow myxomycologist in the Real Jardín Botanico de Madrid, so it lends itself to continuous updating as new slime moulds are described and revisions made. The system evidently operates extremely well, as evidenced by this work, and might be considered a possible candidate for use by other biologists (not only mycologists!) embarking on similarly ambitious major nomenclatural compilations.

Martin G. W. & Alexopoulos, C. J. (1969) *The Myxomycetes.* Iowa City: University of Iowa Press.

Nomenclatural novelties proposed in Mycotaxon, Volume 91

Aliquandostipite crystallinus Raja, A. Ferrer & Shearer, p. 208
Alternaria cosmosa Y.L. Li & W.S. Wu,, p. 15
Alternaria patula H.C. Wu & W.S. Wu, p. 21
Amanita aprica J.E. Lindgren & Tulloss, p. 194
Anthostomella monthadoia I. Promputtha, p. 414
Anthracoidea blanda Vánky & H. Alexander, p. 252
Astrosphaeriella sundarbanensis Jagadeesh & Aptroot, p. 456
Cintractia eleocharidis (Thirum. & Pavgi) Vánky, p. 262
Cistella grumosa Baral, Senn-Irlet & Aeberhardt, p. 406
*Coniophora deflectens (*Bres. & Sydow) Parmasto, p. 147
Curvularia panici W.H. Chung & Tsukib., p. 50
Dactylella coccinella Ying Yang & Xing Z. Liu, p. 128
Dactylella lignatilis M.H. Mo & K.Q. Zhang, p. 186
Decaisnella mediterranea Checa & M.N. Blanco, p. 353
Entyloma bergeniae Vánky & Döbbeler, p. 252
Gloeocantharellus uitotanus Vasco-Palacios & Franco-Molano, p. 90
Graphis argentius Makhija & Adaw., p. 372
Graphis chloroalba Makhija & Adaw., p. 373
Graphis dispersa Makhija & Adaw., p. 373
Graphis distincta Makhija & Adaw., p. 374
Graphis flavovirens Makhija & Adaw., p. 374
Graphis insularis Makhija & Adaw., p. 376
Graphis leptocarpoides Makhija & Adaw., p. 377
Graphis longissimea Makhija & Adaw., p. 377
Graphis palmicola Makhija & Adaw., p. 378
Graphis sitapurensis Makhija & Adaw., p. 378
Heleococcum alkalinum Bilanenko & Ivanova, p. 501
Hemimycena conidiogena Vila, P.-A. Moreau & Pérez-De-Gregorio, p. 324
Hemithecium aphaneomicrosporum Makhija & Adaw., p. 348
Hemithecium scariosum Makhija & Adaw., p. 350
Hemithecium croceum Makhija & Adaw., p. 348
Hemithecium pulchellum Makhija & Adaw., p. 350
Hygroaster iguazuensis B.E. Lechner & J.E. Wright, p. 10
Hydnochaete paucisetigera Parmasto & Sheng H. Wu, p. 461
Hymenochaete pectinata (Bres.) Parmasto, p. 156
Hymenochaete ulmicola Corfixen & Parmasto, p. 465
Jamesdicksonia linearis (Berk. & Broome) Vánky, p. 259
Lactarius dhakurianus K. Das, Basso & J.R. Sharma, p. 3
Leucoagaricus bivelatus B.P. Akers & Ovrebo, p. 304
Macalpinomyces panici Vánky, p. 219
Menegazzia neotropica ssp. *rotundicarpa* Bjerke & Sipman, p. 420
Menegazzia violascens (Räsänen) Bjerke, p. 448
Menegazzia wilsonii (Vain. ex Räsänen) Bjerke, p. 439

Microbotryum primulae (Wettst.) Vánky, p. 260
Mollisia solani Kutorga & Raitv., p. 56
Mycosyrinx usambarensis (Henn.) Vánky, p. 260
Neta mexicana R. F. Castañeda, Heredia & R. Arias, p. 334
Ophiostoma radiaticola J.-J. Kim, Seifert & G.-H. Kim, p. 486
Paecilomyces huaxiensis Z.Q. Liang & Y.F. Han, p. 362
Parmotrema laeve J.B. Chen & Elix, p.102
Pertusaria alboaspera var. *tetraspora* Jariangprasert, p. 280
Pertusaria archerii Jariangprasert, p. 281
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p. 57, line 15	*for:* thicher	*read:* thicker
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